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## Insecticide Sprays: Their Relation to the Control of Leafhoppers by Parasites.

By C. E. Pemberton.

In connection with the present insecticide operations against the cane leafhopper at Olaa Plantation, doubt has been expressed by some as to the advisability of killing the parasites of the hopper in such work. In applying a contact spray to kill the hopper, not only is it destroyed, but parasites, spiders, moths, plant-lice, and in fact a large variety of insects succumb also. Without a complete knowledge of the situation, it is quite natural for one to have fears for the ultimate outcome of such a procedure, when some parasites are actually being destroyed and when it is known that the parasite *Paranagrus optabilis* is our greatest asset on all plantations, in keeping the leafhopper in check.

This particular phase of the subject has been given very careful attention, and the following statement of facts, bearing on the life-cycle and habits of both hopper and parasite and the comparative vulnerability of each to the spray, may serve to allay the fears of any one who will give such facts their thoughtful consideration. It shows that the application of the insecticide is rather of great assistance to the parasites than a check, and very quickly enables them to gain the advantage in the balance of power between the hopper and parasite.

During the winter and spring months of 1920, at Mountain View, it was found that it required about 35 days for the hopper egg to hatch, 62 days for the young hopper to develop to an adult, at least 15 days more before the adult began laying eggs, and that the adult continued laying for at least 20 days. These are averages. There were considerable variations for each. It was found that the parasite completed its entire development, within the hopper egg, in about 42 days, then hatched out and began laying eggs into the hopper eggs immediately, and laid all of its eggs and died in about 5 days more. These figures are taken from a large number of individual records on each stage of development of both hopper and parasite.

From the above figures alone it can readily be seen how much more vulnerable the hopper is to sprays than the parasite. The hopper spends an average of 97 days, out of its total life of 132 days, as an active individual outside of the egg, running about over the surface of the cane leaves. It is in the egg stage, inside of the cane leaf, for 35 days and an active hopper 97 days. The parasite, however, is out of the hopper egg, and exposed to outside influences, for only 5 days of the total period of its existence of 47 days. It is an active parasite 5 days, and a concealed, sealed-up, developing parasite 42 days. Thus about 73 per cent of the hopper's lifetime is spent out on the surface of the cane, while only about 10 per cent of the parasite's life is lived in such exposure. Hence at any one time during a season of spraying, the chances of a ratio of more parasites than hoppers being destroyed, are exceedingly small. It is almost inevitable, under the circumstances of life habit of the two insects, that the parasites will be greatly assisted, even though some of their forces be lost. A much greater proportion of all hoppers present will be destroyed than parasites and a change in balance is quickly effected. This is not a hypothetical case. It is not assumed without proof. These facts alone, if rightly examined, should be sufficient.

As soon as the parasite hatches out it begins ovipositing; that is, it begins laying its eggs in leafhopper eggs. A leafhopper, however, does not begin laying until about 77 days after hatching out. This means that vastly more parasites, that may have been killed by the spray, have already laid from one-fifth to five-fifths of all the eggs they could ever have laid, than hoppers which may have been killed. Almost every parasite will have already laid some eggs, while a large number of hoppers, usually a majority, will either have not yet deposited any eggs, are still immature, or have laid only a few eggs. This all points in favor of the parasite in relation to the spray work.

By way of repetition, it must not be thought that the killing of all parasites on the cane leaves, in the operation of killing the hopper, exterminates the parasites from the field. It must always be remembered that vastly more parasites are always present and developing in the hopper eggs, safely sealed in the cane leaves, than outside, flying or running about.

If it were possible to kill every living parasite and hopper present on the leaf surfaces in an infested area of cane, there would be no more hoppers laying eggs in this area for at least 77 days, assuming that some young hoppers commenced hatching out the following day after spraying. It would be 77 days before they would be old enough to lay (using the above figures for the Mountain View conditions). However, parasites would continue hatching out of the leaves immediately after the spraying, and begin attacking all remaining unparasitized hopper eggs, and continue so hatching out and attacking hopper eggs to some extent during at least the following 35 days, or until all hopper eggs had been parasitized or had hatched. It would mean that hopper eggs would not be laid for 77 days, but parasites would continue laying from 30 to 35 days more. One is going ahead and the other is standing still. It thus gives the parasite a very great ascendency, and a sudden one, by stopping the egg-laying of the hopper, but not checking that of the parasite. All parasites that hatch out tomorrow will be actively laying tomorrow, and so on for a month,

while all hoppers which hatch tomorrow, and the days following, must wait 77 days before old enough to lay. A second spraying, then, before 77 days have elapsed is still more effective. The determination of the fact that the parasite attacks and successfully develops on hopper eggs even when they are old and ready to hatch adds weight to our present argument.

The danger of totally exterminating the parasite in the cane, by totally eliminating the hopper, is negligible. The total eradication of the hopper would, of course, leave no food for the parasite, and it would soon disappear. Even this would be desirable, but it can never be accomplished. The efficiency of the average laborer in applying the spray will always be so low that many hoppers will not be killed. A certain percentage will be unavoidably missed. The remaining few will always leave sufficient eggs in the cane, at any one time, to supply food for the development and perpetuation of the parasites in all fields, no matter how isolated from others.

In practice, as a matter of fact, no detrimental effect of the spray upon the parasite has arisen. The parasitism in the sprayed fields has increased from a very low point after the spraying commenced, to a much higher percentage at present, only a short period later. This increase would have occurred naturally, in considering the cycle of hopper and parasite during the spring months, even without spraying, but it is felt with certainty that it could not have been so rapid, had it not been for the spraying. There has been absolutely no visible interference with parasite activities by sprays, and the coincident increase in parasitism has been surprisingly rapid, and wholly in keeping with the predictions originally drawn from the figures and facts above cited. In the sprayed fields, during March and April, the parasitism ranged from 20 to 30 per cent. On May 9th, the date of the last observation, an examination was made of over 4,000 hopper eggs, taken in several sections of the same areas. The parasitism had then jumped to 69 per cent. These facts should be sufficient to show that no alarming check is given the parasites, by spraying to kill the hoppers, and that actually it assists rather than retards their general effectiveness. It is further significant to know that a decided response in the growth of the cane has accompanied this increase in parasitism, and the decrease of a host of hoppers through the action of the sprays and the use of hopper catchers operated over the entire affected area at the same time.

## The Kapok or Silk-Cotton Tree.

*Ceiba pentandra* (L.) Gaertner.

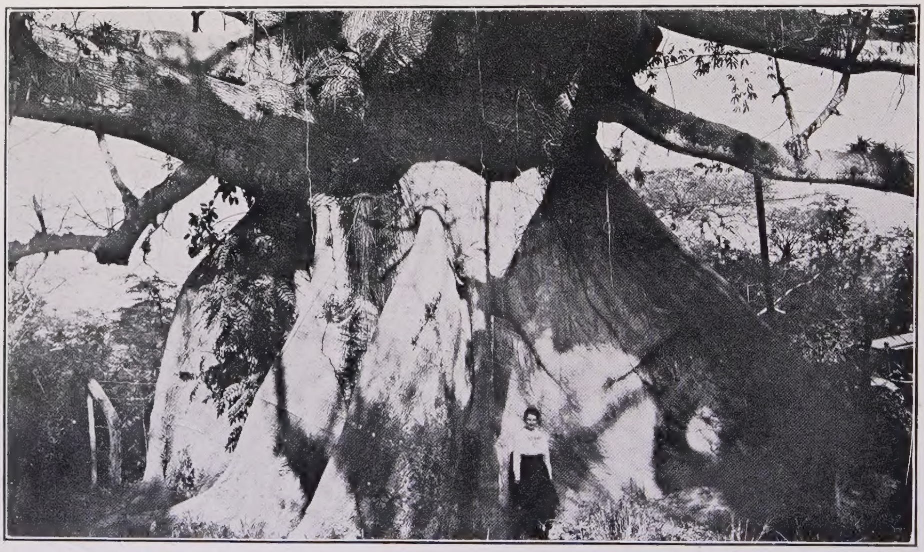
By H. L. Lyon.

On the cover of this issue we reproduce a picture of a large silk-cotton tree which stands beside one of the main thoroughfares of Jamaica, only a short distance from Kingston. The tree is in itself a very fine specimen of the species, and quite worthy of respect, but it is venerated in Jamaica, for it is the identical

tree mentioned in that famous record of pirate days, "Tom Kringle's Log," and as a result it is popularly known and treasured as Tom Kringle's Tree.

As can be readily seen from the photograph, the main axis of this particular specimen is a short cone supported on all sides by massive buttresses, which suggest enormous strength and stability. The greatest distance through the trunk and its buttresses at the surface of the ground is somewhat over forty feet. At a comparatively short distance above ground the trunk divides up into numerous huge branches, many of which are nearly or quite horizontal, and extend out fifty feet and more from the trunk. These branches carry a veritable garden of perching plants, among which are several species of orchids, numerous pineapple-like Tillandsias and a night-blooming Cereus.

Tom Kringle's Tree represents the form taken by a silk-cotton tree when it is not closely surrounded by other trees, and can push out its branches without interference at a comparatively short distance above the ground. As a component of a forest, however, it is usually a very tall tree, and spreads its lowermost, permanent branches at a considerable distance above the earth. Such specimens are even more imposing than Tom Kringle's Tree, for when in full leaf they present a broad, dense crown borne at a great height on a huge columnar trunk.



Tom Kringle's Tree. The bole is reenforced on all sides by far-flung buttresses.

In Cuba we saw many specimens with immense trunks on which the first branches were fifty to seventy feet from the ground. These trees now stand in cane fields and pastures, but they undoubtedly grew to maturity as components of a forest, and the proximity of other trees caused them to push their crowns to an unusual height in order to monopolize the light.

The silk-cotton tree is native to the tropics of both hemispheres. It is known as "Seiba" in Cuba, and "Kapok" in Java. It is a quick-growing tree of the lowlands. The wood is soft and of little value as timber or fuel, but the trunks

A silk-cotton tree growing in the grounds of the Territorial Nursery on King Street. Note the horizontal position of the branches. This is one of the striking characteristics of the silk-cotton tree.

are used by some peoples in making dug-out canoes. The bark yields a medicinal gum and an inferior fiber.

In the orient, particularly in Java, Ceylon, and the Philippines, the floss, or "silk-cotton," which surrounds the seeds is an article of commerce under the Javanese name *Kapok*. It is used chiefly for upholstering; stuffing pillows, mattresses and the like. It has also been extensively used as a filler for life-belts, buoys, etc. The fiber is too short, smooth and light to be used for textile purposes. In 1912 the oriental countries marketed some 9,000 tons of kapok, of which 8,000 tons were produced in Java. The market price averaged somewhat over $200 per ton.

"The seeds yield 28 per cent of an oil that much resembles cotton-seed oil, and the cake is found to be a highly beneficial cattle food. The oil is used in Holland as food and in the manufacture of soap. It dries more rapidly than cotton-seed oil." [1]

The silk-cotton tree is easily propagated by seeds or cuttings, and thrives from sea level up to 2,000 feet elevation. It is extensively planted along roadsides and in hedgerows in Java, where the kapok is most valued. In the West Indies the tree is not planted to any extent, as there seems to be no interest in the floss as a commercial product.

There are many silk-cotton trees now growing in and about Honolulu. A handsome specimen may be seen in front of the Capitol building on the Ewa side of the drive, while a smaller tree stands on the Waikiki side. Two fine large trees are flourishing in Mrs. Foster's grounds on Nuuanu avenue, and two big trees may be seen on the Waikiki side of upper Nuuanu a short distance below the Queen Emma home. The subject of our photograph on the preceding page stands in the Territorial Nursery on King street, near the Ewa end of the grounds.

A silk-cotton tree may be recognized:

By the straight main axis which usually tapers off rapidly above the first branches;

By the strikingly wide angles at which its branches leave the main axis, many of these being, as a rule, quite horizontal;

By the large conical spines which occur on the trunks of young trees, and on the newer portions of the branches of old trees, but which drop off as the members grow old;

By its palmately compound leaves with five to nine narrow, pointed, stalked leaflets arranged in a whorl at the end of a long petiole;

By its large shuttle-shaped capsules, four to eight inches long, which are closely packed with a copious floss surrounding the seeds;

By its deciduous habit, for it drops all of its foliage and remains bare for a short period each year.

While conspicuous buttresses at the base of the trunk are characteristic of silk-cotton trees, still specimens are occasionally met with which show these only slightly developed or altogether lacking.

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[1] The Commercial Products of India, by Sir George Watt.

# The Fern Weevil Menace.*

By D. T. Fullaway.†

Brief mention was made in the October *Forester* of the discovery, in September, of a serious infestation of the beautiful Sadleria ferns in the neighborhood of Kilauea by the Australian fern weevil, *Syagrius fulvitarsis,* and of the efforts made to suppress it. With the result of this undertaking still uncertain, a more troublesome situation is disclosed. The weevil, it is found, has escaped from one or two greenhouses in Hilo, to which it was supposed to be confined, and has spread all over the city, from Wainaku to Waiakea, on the fish-tail fern. It does not appear feasible to eradicate it in so extensive an area, and the only control measure which recommends itself at present is isolation, which may serve to protect the forests from invasion for a period. At all events, the possibility of invasion is no longer remote, and it seems important to consider now what the consequence would be should this beetle succeed in securing a firm foothold in the forests.

An examination of the Sadleria ferns in the mountains back of Honolulu, where the beetle has been present for 15 years, reveals the destructive nature of the insect. The fern growth there is thin, compared with that at Kilauea, yet it is impossible to find a single plant that has not suffered severely from the ravages of the beetle. As the attacks appear to be continuous, it seems certain that the ferns, in spite of their hardiness, will eventually succumb. At Kilauea, the shattered condition of the ferns was more noticeable on account of the thickness of the stand. In these dense forests, ferns constitute an important part of the ground cover. It is to be expected that their destruction will be followed by a train of attendant evils, such as the entrance of light, drying of the ground, the invasion of weeds, etc. The sensitiveness of the Hawaiian forests to disturbance is so well known that the result can be definitely predicted — a progressive debility of the trees on the edge of the invaded areas, a dying back of the forest, ultimately its extinction. It would seem necessary, therefore, to make every effort to prevent the fern weevil from gaining further access to the forests.

Illustrations of the different stages of the fern weevil accompany this article.

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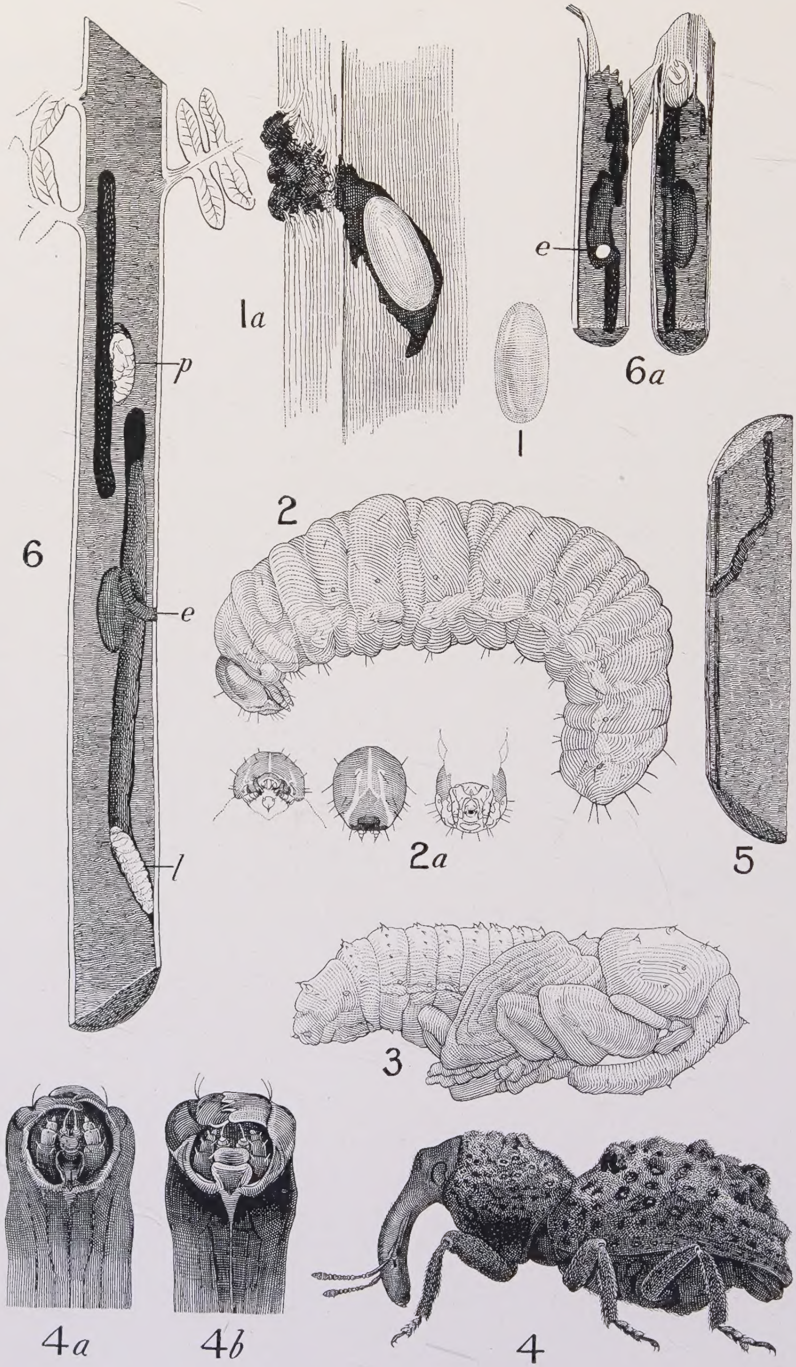
*The Hawaiian Forester and Agriculturist, January, 1920.
†Entomologist, Board of Agriculture and Forestry.




The Fern Weevil. (*Syagrius fulvitarsis* Pasc.) 1, Egg (greatly enlarged); 1a, section of fern stem showing egg-chamber (greatly enlarged). 2, larva; 2a, head of larva from front, above, and beneath, showing mouthparts (x10). 3, pupa (x10). 4, adult weevil (x10); 4a, b, apical extremity of rostrum showing mouthparts (greatly enlarged). 5, section of fern stem showing gallery of freshly-hatched larva (somewhat enlarged). 6, section of fern stem showing galleries of more advanced larvae and pupal chamber with exit; l, larva, p, pupa, e, exit (somewhat enlarged); 6a, portion of the preceding in greater detail.

# Animal Cultivation at Hakalau.

*Hakalau Cultivation Experiment. 1920 Crop.**

In this test the following comparisons were made:

"A" plots—Regular plantation practice; offbarring, hilling-up, and all other animal work.

"B" plots—No animal cultivation; weeds controlled by hoeing and fertilizer covered by hand.

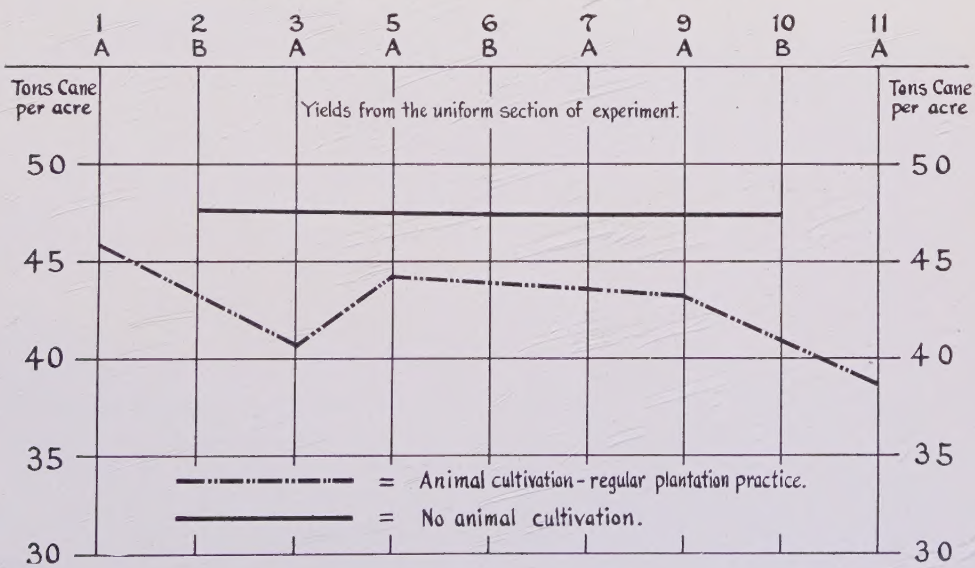
"C" plots—Not offbarred; all other animal work subsequently, as in "A" plots.

The results show a gain of 0.84 ton of sugar per acre for the plots receiving no animal cultivation as against the regular plantation practice. However, this increase was obtained at a higher cost, and was attended by an abnormal drain on the labor supply. The plots which were not offbarred produced one-half of a ton of sugar more per acre than did the plots which were offbarred.

An examination of the quality of the cane shows that the best juices were from the "no cultivation" plots, while the poorest juices were from the plots which received the most cultivation.

In experiments harvested at the Hilo Sugar Company last year (Planters'

HAKALAU CULTIVATION EXPERIMENT 1920 CROP
(Conducted By Plantation)
Curves Showing The Yields Of Cane Per Acre From The Cultivation And the No Cultivation Plots.




*Experiment planned and conducted by plantation. Harvested by Mr. W. L. S. Williams.

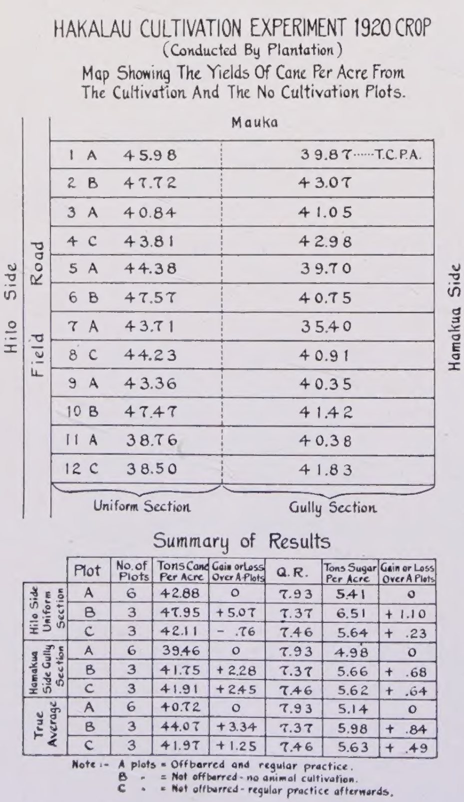
Record, Vol. XXI, page 153), results of an opposite nature were obtained—that is, the best juices were from the plots receiving the most cultivation, but in all cases those plots produced less cane.

The following summarizes the plot yields:

| | Treatment | Tons Cane per Acre | Gain or Loss Over "A" Plots | Q. R. | Tons Sugar per Acre | Gain or Loss Over "A" Plots |
|---|---|---|---|---|---|---|
| Hilo side— Uniform section | A* | 42.880 | 0 | 7.93 | 5.41 | 0 |
| | B† | 47.954 | + 5.074 | 7.37 | 6.51 | + 1.10 |
| | C‡ | 42.114 | — 0.766 | 7.46 | 5.64 | + 0.23 |
| Hamakua side— Gully section | A | 39.462 | 0 | 7.93 | 4.98 | 0 |
| | B | 41.750 | + 2.288 | 7.37 | 5.66 | + 0.68 |
| | C | 41.912 | + 2.450 | 7.46 | 5.62 | + 0.64 |
| True average | A | 40.723 | 0 | 7.93 | 5.14 | 0 |
| | B | 44.072 | + 3.349 | 7.37 | 5.98 | + 0.84 |
| | C | 41.978 | + 1.255 | 7.46 | 5.63 | + 0.49 |

*Regular plantation practice. †No animal cultivation. ‡No offbarring.

Careful records were kept as to the exact number of men and animals that were needed to perform the operations in this test. From these have been figured cost data which increase the value of the results of the experiment. In Table I is shown the number of men and animal hours used in each plot. In Table II there have been calculated the costs per acre based upon a charge of ten cents per hour for men, and eight cents per hour for animals, and the total cost per ton of sugar produced.




An anlysis of these figures shows:

(1) It cost $8.42 per acre more to care for the cane on the "B" plots (no animal work) than on the "A" plots (regular plantation practice). However, 0.84 ton of sugar more was produced on the "B" plots, which more than counterbalances the additional cost. Taking into consideration the cost per ton of sugar, the charge against the "A" plots is $3.45 as against $3.86 for the "B" plots.

(2) What were the items that went to make this additional cost for the "B" plots? First, the fertilizer was covered in the "B" plots at a cost of

$2.16 per acre. Second, there was required an extra hoeing in the "B" plots, which cost almost $7.00 per acre.

(3) From the figures of the "C" plots where offbarring was omitted, we note an interesting fact. It cost $2.13 per acre to give the first cultivation as against $0.70 per acre in the "A" plots, which were offbarred. It is common knowledge that it is always difficult to use cultivators or Horner harrows where the kuakua contains no loose earth, such as is thrown up by offbarring, to cover the weeds. This difference of $1.43 per acre between the "A" and "C" plots corroborates observations on this point.

In reporting on this experiment one must pay tribute to the late Robert Clark, of Hakalau Plantation Co., whose intense interest on the subject of cultivation contributed greatly to the success of this experiment.

TABLE I

DETAILED SCHEDULE OF MEN AND ANIMAL WORK IN HOURS FOR EACH PLOT.

| | 2-B | 6-B | 10-B | Average per Plot | Average per Acre |
|---|---|---|---|---|---|
| 1st hoeing .............. | 16.50 | 16.50 | 16.50 | 16.50 | 47.60 |
| 2nd hoeing .............. | 16.00 | 16.00 | 16.00 | 16.00 | 46.20 |
| 3rd hoeing .............. | 24.00 | 24.00 | 24.00 | 24.00 | 69.30 |
| Hoeing and stripping .... | 16.00 | 16.00 | 16.00 | 16.00 | 46.20 |
| Total hoeing .......... | 72.50 | 72.50 | 72.50 | 72.50 | 209.30 |
| Covering fertilizer ....... | 7.50 | 7.50 | 7.50 | 7.50 | 21.65 |

TABLE I (Continued)

DETAILED SCHEDULE OF MEN AND ANIMAL WORK IN HOURS FOR EACH PLOT.

| | 4-C | | 8-C | | 12-C | | Average per Plot | | Average per Acre | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A. | M. | A. | M. | A. | M. | | | | |
| Offbarring .......... | ..... | ..... | ..... | ..... | ..... | ..... | ...... | ...... | ...... | ...... |
| Hilling-up .......... | 1.30 | 1.30 | 1.67 | 1.67 | 2.10 | 2.10 | 1.69 | 1.69 | 4.77 | 4.77 |
| 1st cultivation ...... | 9.00 | 9.00 | 9.25 | 9.25 | 10.10 | 10.10 | 9.46 | 9.46 | 26.72 | 26.72 |
| 2nd cultivation ...... | 1.67 | 1.67 | 1.75 | 1.75 | 2.33 | 2.33 | 1.91 | 1.91 | 5.39 | 5.39 |
| Total ............ | 11.97 | 11.97 | 12.67 | 12.67 | 14.53 | 14.53 | 13.06 | 13.06 | 36.88 | 36.88 |
| 1st hoeing .......... | ..... | 16.50 | ..... | 13.50 | ..... | 13.50 | ...... | 14.60 | ...... | 41.24 |
| 2nd hoeing .......... | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ...... | 16.00 | ...... | 45.20 |
| 3rd hoeing .......... | ..... | ..... | ..... | ..... | ..... | ..... | ...... | ...... | ...... | ...... |
| Hoeing and stripping | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ...... | 16.00 | ...... | 45.20 |
| Total ............ | ..... | 48.50 | ..... | 45.50 | ..... | 45.50 | ...... | 46.60 | ...... | 131.64 |

TABLE I (Continued)

DETAILED SCHEDULE OF MEN AND ANIMAL WORK IN HOURS FOR EACH PLOT.

| | 1-A | | 3-A | | 5-A | | 7-A | | 9-A | | 11-A | | Average per Plot | | Average per Acre | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A. | M. | A. | M. | A. | M. | A. | M. | A. | M. | A. | M. | | | | |
| Offbarring ............... | 2.00 | 1.33 | 2.00 | 1.33 | 2.50 | 1.67 | 3.00 | 2.00 | 3.00 | 2.00 | 3.75 | 2.50 | 2.70 | 1.80 | 7.86 | 5.24 |
| Hilling-up ............... | 1.30 | 1.30 | 1.50 | 1.50 | 1.67 | 1.67 | 1.55 | 1.55 | 1.83 | 1.83 | 1.91 | 1.91 | 1.62 | 1.62 | 4.72 | 4.72 |
| 1st cultivation .......... | 2.50 | 2.50 | 2.75 | 2.75 | 3.00 | 3.00 | 3.14 | 3.14 | 3.25 | 3.25 | 3.50 | 3.50 | 3.02 | 3.02 | 8.80 | 8.80 |
| 2nd cultivation .......... | 1.60 | 1.60 | 1.75 | 1.75 | 1.67 | 1.67 | 2.00 | 2.00 | 2.00 | 2.00 | 2.25 | 2.25 | 1.88 | 1.88 | 5.47 | 5.47 |
| Total ................. | 7.40 | 6.73 | 8.00 | 7.33 | 8.84 | 8.01 | 9.69 | 8.69 | 10.08 | 9.08 | 11.41 | 10.16 | 9.22 | 8.32 | 26.85 | 24.23 |
| 1st hoeing .............. | ..... | 13.50 | ..... | 13.50 | ..... | 13.50 | ..... | 13.50 | ..... | 13.50 | ..... | 13.50 | ...... | 13.50 | ...... | 39.30 |
| 2nd hoeing .............. | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ...... | 16.00 | ...... | 46.60 |
| 3rd hoeing .............. | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ...... | ...... | ...... | ...... |
| **Hoeing and Stripping** ..... | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ..... | 16.00 | ...... | 16.00 | ...... | 46.60 |
| Total ................. | ..... | 45.50 | ..... | 45.50 | ..... | 45.50 | ..... | 45.50 | ..... | 45.50 | ..... | 45.50 | ...... | 45.50 | ...... | 132.50 |

TABLE II

DETAILED STUDY OF COSTS PER ACRE FOR EACH TREATMENT.

| Plot | Offbarring | | | Hilling | | | 1st Cultivation | | | 2nd Cultivation | | | Total Cultivation Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aml. | Men | T'tl. | Aml. | Men | T'tl. | Aml. | Men | T'tl. | Aml. | Men | T'tl. | Aml. | Men | T'tl. |
| A .................... | $ .62 | $ .52 | $1.14 | $ .38 | $ .47 | $ .85 | $ .70 | $ .88 | $1.58 | $ .43 | $ .55 | $ .98 | $2.13 | $2.42 | $4.55 |
| C .................... | .... | .... | .... | .38 | .47 | .85 | 2.13 | 2.67 | 4.80 | .48 | .53 | 1.01 | 2.99 | 3.67 | 6.66 |
| B .................... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |

TABLE II (Continued)

DETAILED STUDY OF COSTS PER ACRE FOR EACH TREATMENT.

| Plot | 1st Hoeing | 2nd Hoeing | 3rd Hoeing | Hoeing Strpng. | Cover Fert. | Total | Total Cost per Acre | | | Total Cost per Ton Sugar | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Men | Men | Men | Men | Men | Men | Anml. | Men | Total | Anml. | Men | Total |
| A .................... | $3.93 | $4.66 | .... | $4.66 | .... | $13.25 | $2.13 | $15.67 | $17.80 | $ .41 | $3.04 | $3.45 |
| C .................... | 4.12 | 4.52 | .... | 4.52 | .... | 13.16 | 2.99 | 16.83 | 19.82 | .53 | 2.99 | 3.52 |
| B .................... | 4.76 | 4.62 | $6.93 | 4.62 | $2.16 | 23.09 | .... | 23.09 | 23.09 | .... | 3.86 | 3.86 |

## Details of Experiment.

*Hakalau Cultivation Experiment.* 1920 *Crop.*

*Object:*

To observe the value of cultivation operations, which are a part of the regular plantation practice.

*Location:*

Hakalau Plantation Co., Field 24.

*Crop:*

Yellow Caledonia, 1st ratoons.

*Layout:*

Number of plots = 12.

Size of plots = about 1/3 acre, consisting of 6 lines.

| Plot | No. | Area | Plot | No. | Area | Plot | No. | Area |
|---|---|---|---|---|---|---|---|---|
| A | 1 | .3142 | B | 2 | .3289 | C | 4 | .3277 |
| A | 3 | .3229 | B | 6 | .3418 | C | 8 | .3587 |
| A | 5 | .3338 | B | 10 | .3681 | C | 12 | .3755 |
| A | 7 | .3506 | | | | | | |
| A | 9 | .3647 | | | | | | |
| A | 11 | .3721 | | | | | | |
| Avg. | | .3431 | | | .3463 | | | .3539 |

*Plan:*

| Plots | Treatment |
|---|---|
| A | Regular plantation practice: offbarring, hilling-up and all other animal work. |
| B | No animal cultivation. Weeds controlled by hoeing and fertilizer covered by hand. |
| C | Not offbarred. All other animal work subsequently, as in "A" plots. |

J. A V.–W. P. A.

# Fertilizing First Ratoons Under Grove Farm Conditions.

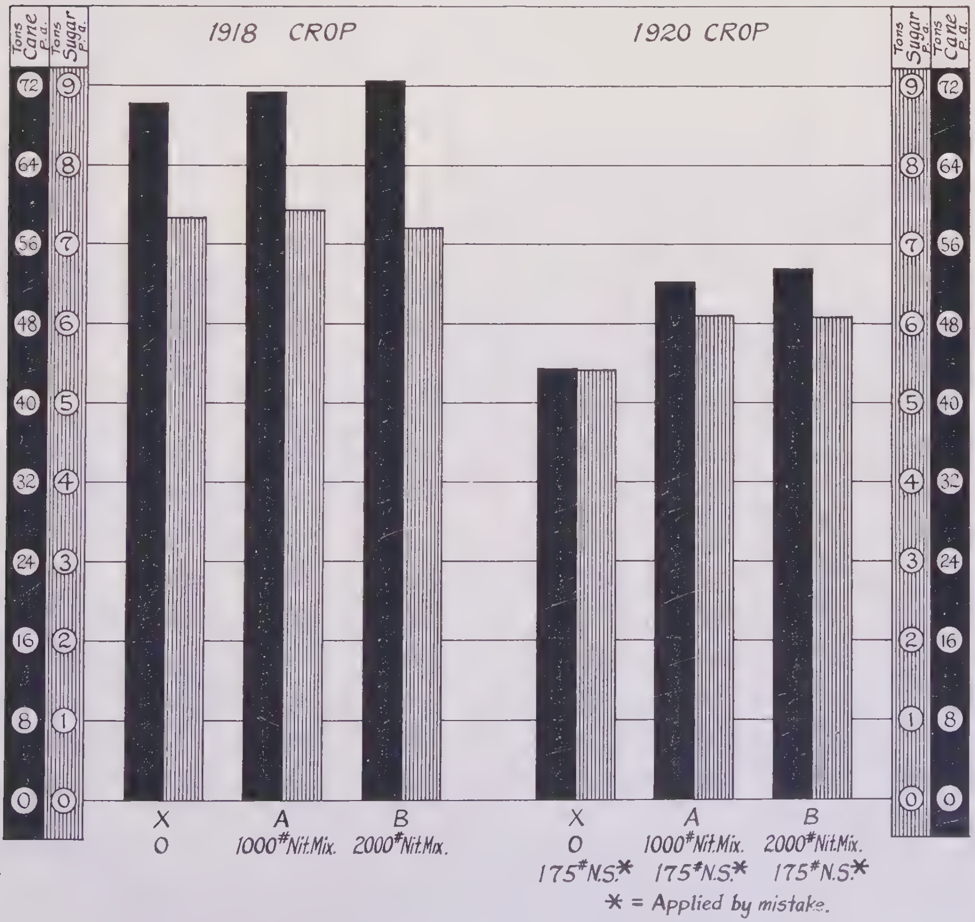
*Grove Farm Experiments 2, 3, 4, and 5, 1920 Crop.*


## Summary.

These experiments consisted of a series of studies of nitrogen applications, including amount to apply, time of application, and forms of nitrogen. These experiments are continuations of those harvested in 1918, and reported in Record Vol. XIX, page 270.

The cane involved is D 1135, first ratoons. The previous crop was harvested in April, 1918, nothing further being done to the experimental area until the latter part of the following July, when the cane was hilled up, weeded, and irrigated,


FERTILIZER RESULTS WITH PLANT & THE FOLLOWING FIRST RATOONS.
GROVE FARM EXPERIMENT No.2, 1918 & 1920 CROPS



without having been cut back. Fertilizations began in September. During October, 1918, 175 pounds of nitrate of soda (27 pounds of nitrogen) was uniformly applied by mistake in the irrigation water to all these experiments.

The results of the different treatments follow:

EXPERIMENT NO. 2 — AMOUNT TO APPLY.

| Plots | Treatment | Yield per Acre | | | Gain Over No Fertilization | |
|---|---|---|---|---|---|---|
| | | Cane | Q. R. | Sugar | Cane | Sugar |
| X | 175 lbs. nitrate soda | 43.4 | 8.02 | 5.42 | 0 | 0 |
| A | 1,000 lbs. nitrogen mixture plus 175 lbs. nitrate soda | 52.3 | 8.55 | 6.12 | 8.9 | .70 |
| B | 2,000 lbs. nitrogen mixture plus 175 lbs. nitrate soda | 53.6 | 8.80 | 6.09 | 10.2 | .67 |

EXPERIMENT NO. 3 — TIME OF APPLICATION.

| Plots | Treatment | Yield per Acre | | |
|---|---|---|---|---|
| | | Cane | Q. R. | Sugar |
| A | 1,000 lbs. nitrogen mixture in 4 equal doses, two first and two second season, plus 175 lbs. nitrate of soda | 55.1 | 8.38 | 6.53 |
| C | 1,000 lbs. nitrogen mixture, in 2 doses; second season plus 175 lbs. nitrate of soda | 57.5 | 8.86 | 6.49 |
| D | 1,000 lbs. nitrogen mixture, in 2 doses; first season plus 175 lbs. nitrate of soda | 54.3 | 8.84 | 6.16 |

EXPERIMENT NO. 4 — AMOUNT TO APPLY SECOND SEASON.

| Plots | Treatment | Yield per Acre | | |
|---|---|---|---|---|
| | | Cane | Q. R. | Sugar |
| C | 500 lbs. nitrogen mixture, in 2 doses, plus 175 lbs. nitrate of soda | 55.3 | 8.91 | 6.20 |
| E | 250 lbs. nitrogen mixture, in 2 doses, plus 175 lbs. nitrate of soda | 56.1 | 8.52 | 6.59 |

EXPERIMENT NO. 5—FORMS OF NITROGEN.

| Plots | Treatment | Lbs. of Nitrogen | Yields per Acre | | |
|---|---|---|---|---|---|
| | | | Cane | Q. R. | Sugar |
| A | 1,000 lbs. nitrogen mixture, in 4 equal doses: two first season; two second season, plus 175 lbs. nitrate of soda | 150 | 56.1 | 8.99 | 6.24 |
| F | 1,000 lbs. nitrogen mixture, 1 dose, August, 1916, plus 175 lbs. nitrate of soda | 150 | 57.7 | 8.90 | 6.49 |
| G | 1,250 lbs. blood; 12% nitrogen; one dose, August, 1916, plus 175 lbs. nitrate of soda | 150 | 57.1 | 8.59 | 6.64 |

The nitrogen mixture used in the above experiments was 15% nitrogen (6% from nitrate of soda, 6% from sulfate of ammonia, and 3% from organic sources).

The results of experiment No. 2 show 177 pounds of nitrogen to give a gain of 0.70 ton of sugar over **27 pounds of nitrogen from nitrate of soda applied in the irrigation water in October,** while 327 pounds of nitrogen not only produces no further increase, but causes a slight loss, due to poorer juices. This is in marked contrast to the results of last crop, when fertilization produced no increase at all. This difference in response to fertilizer by plant and first ratoons is shown graphically in the accompanying cut.

It may be possible that even 177 pounds of nitrogen exceeds the profitable limit of fertilization, for comparing experiment No. 2 with No. 4, which is also amount to apply, though at different times, we find that 102 pounds nitrogen produce slightly better results than 177 pounds. The difference in yields between 102 pounds and 177 pounds is within the limits of experimental error, but it is interesting to note that the lesser amount produces as good results as the greater.

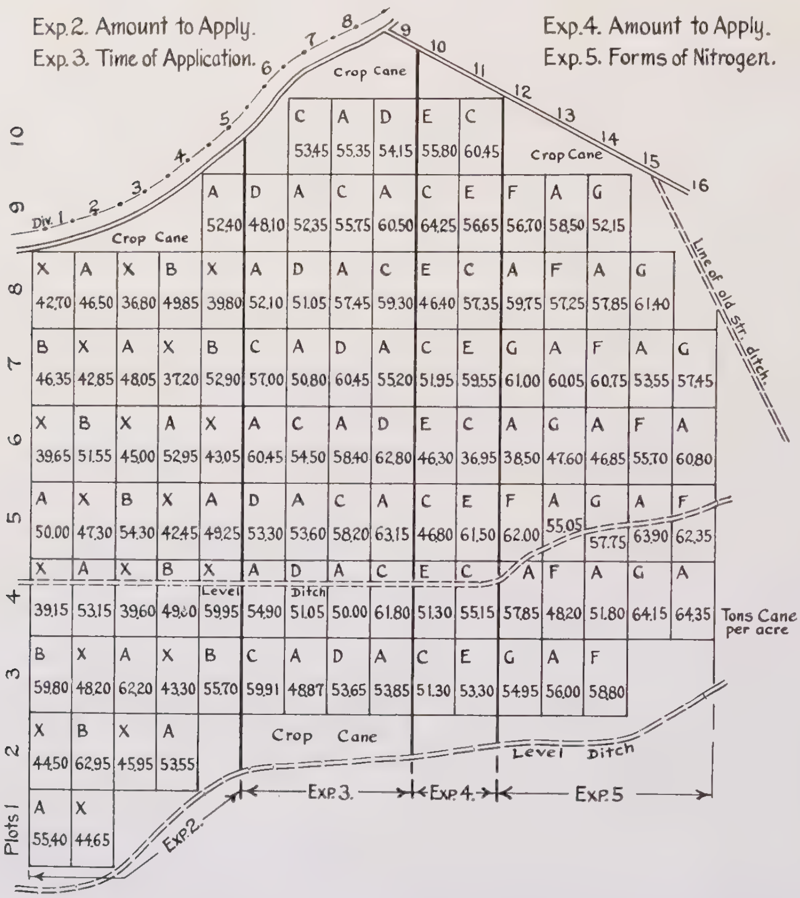
In experiment No. 3 the value of second season fertilization is clearly shown. The "D" plots, which received no fertilizer the second season, produced .37 ton less sugar than the average of the "A" and "C" plots, both of which received part of their fertilizer the second season.

The difference between the yields of the "A" and "C" plots,—a difference well within the limits of experimental error,—is so small that it gives no indication as to whether the fertilizer should be divided between the two seasons or all applied the second season.

In experiment No. 5, nitrogen in one dose (except for the small application of nitrate of soda in the water) from blood produces slightly better results than nitrogen mixture, either in one or several doses. The difference is due entirely to the quality of the juice. The difference in the amount of cane is well within the limits of experimental error.

These experiments are all to be continued for another crop.

# GROVE FARM EXPERIMENTS 2, 3, 4 & 5, 1920 CROP




## Summary of Results (Exp. 2)

| Plot | No. of Plots | Treatment | Lbs. N. S. Oct. 1918 | Tons P.A. Cane | Q.R. | Tons P.A. Sugar |
|---|---|---|---|---|---|---|
| X | 18 | No fertilizer | 175 | 43.45 | 8.02 | 5.42 |
| A | 10 | 1000# Nitrate Mixture | 175 | 52.35 | 8.55 | 6.12 |
| B | 9 | 2000# Nitrate Mixture | 175 | 53.60 | 8.80 | 6.09 |

## Summary of Results (Exp. 3)

| Plot | No. of Plots | Treatment | Lbs. N. S. Oct. 1918 | Tons P.A. Cane | Q.R. | Tons P.A. Sugar |
|---|---|---|---|---|---|---|
| A | 15 | 150#N. Both seasons in 4 equal doses | 175 | 55.13 | 8.38 | 6.58 |
| C | 8 | 150#N. 2nd season in 2 equal doses | 175 | 57.49 | 8.86 | 6.49 |
| D | 8 | 150#N. 1st season in 2 equal doses | 175 | 54.32 | 8.84 | 6.15 |

## Summary of Results (Exp. 4)

| Plot | No. of Plots | Treatment | Lbs. N. S. Oct. 1918 | Tons P.A. Cane | Q.R. | Tons P.A. Sugar |
|---|---|---|---|---|---|---|
| C | 8 | 150#N. 2nd season in 2 equal doses | 175 | 55.28 | 8.91 | 6.20 |
| E | 8 | 75#N. 2nd season in 2 equal doses | 175 | 56.10 | 8.52 | 6.59 |

## Summary of Results (Exp. 5)

| Plot | No. of Plots | Treatment | Lbs. N. S. Oct. 1918 | Tons P.A. Cane | Q.R. | Tons P.A. Sugar |
|---|---|---|---|---|---|---|
| A | 14 | 1000#N.M. Both seasons in 4 equal doses | 175 | 56.13 | 8.99 | 6.24 |
| F | 8 | 1000# Nit. Mix. 1st season in 1 dose | 175 | 57.72 | 8.90 | 6.49 |
| G | 8 | 1250# Blood 1st season in 1 dose | 175 | 57.06 | 8.59 | 6.64 |

## Details of the Experiments.

### *Grove Farm Experiment No. 2 (1920 Crop).*

Fertilizer Experiment—Amount to apply to first ratoons. (O. 150, 300 lbs. nitrogen per acre.)

*Object:*

To determine the most profitable amount of nitrogen per acre to apply to ratoon cane under Grove Farm conditions.

*Location:*

Field 6.

*Crop:*

D 1135, 1st ratoons.

*Layout:*

Number of plots, 37.

Size of plots, 1/10 acre each (48.3′x90.2′). Rows irregular; plots one water course wide.

*Plan:*

FERTILIZATION* IN POUNDS PER ACRE PER APPLICATION.

| Plots | No. plots | Aug. 1918 | Oct. 1918 | Nov. 1918 | Feb. 1919 | May 1919 | Total Lbs. Nitrogen |
|---|---|---|---|---|---|---|---|
| X ......... | 18 | 0 | †175 | 0 | 0 | 0 | 27 |
| A ......... | 10 | 250 | †175 | 250 | 250 | 250 | 177 |
| B ......... | 9 | 500 | †175 | 500 | 500 | 500 | 327 |

*Fertilizer used, 15% nitrogen (6% nitrate, 6% sulfate, 3% organic).
†Nitrate of soda.

*Progress:*

Sept. 22, 1918—First fertilization.
Oct. 1918—All plots, by mistake, received 175 lbs. nitrate of soda in irrigation water.
Dec. 19, 1918—Second fertilization.
Feb. 4, 1919—Third fertilization.
June 6, 1919—Fourth fertilization.
March, 1920—Experiment harvested by J. H. Midkiff.

### *Grove Farm Experiment No. 3 (1920 Crop).*

Fertilizer Experiment—Time of application.

*Object:*

To determine the best time to apply a given amount of fertilizer to ratoon cane.

*Location:*

Field 6.

*Crop:*

D 1135, 1st ratoons.

*Layout:*

Number of plots, 31.

Size of plots, 1/10 acre each (48.3′x90.2′). Rows irregular; plots one water course wide.

*Plan:*

FERTILIZATION*—POUNDS FERTILIZER PER ACRE

| Plots | No. plots | Aug. 1918 | Oct. 1918 | Nov. 1918 | Feb. 1919 | May 1919 | Total Lbs. Nitrogen |
|---|---|---|---|---|---|---|---|
| A ......... | 15 | 250 | †175 | 250 | 250 | 250 | 177 |
| C ......... | 8 | 0 | †175 | 0 | 500 | 500 | 177 |
| D ......... | 8 | 500 | †175 | 500 | 0 | 0 | 177 |

*Fertilizer used: 15% nitrogen (6% nitrate, 6% sulfate, 3% organic).
†Nitrate of soda.
Experiment planned by R. S. Thurston and J. A. Verret.

*Progress:*

Sept. 22, 1918—First fertilization.
Oct. 1918—All plots, by mistake, received 175 lbs. nitrate soda in irrigation water.
Dec. 19, 1918—Second fertilization.
Feb. 4, 1919—Third fertilization.
June 6, 1919—Fourth fertilization.
April, 1920—Experiment harvested by J. H. Midkiff.

## *Grove Farm Experiment No. 4 (1920 Crop).*

### Fertilizer Experiment—Amount to apply second season.

*Object:*

To determine the most profitable amount of fertilizer to apply to first ratoons during the second season.

*Location:*

Field 6.

*Crop:*

D 1135, 1st ratoons.

*Layout:*

Number of plots, 16.
Size of plots, 1/10 acre each (48.3′x90.2′). Rows irregular; plots one water course wide.

*Plan:*

FERTILIZATION*—POUNDS PER ACRE

| Plots | No. plots | Aug. 1918 | Oct. 1918 | Nov. 1918 | Feb. 1919 | May 1919 | Total Lbs. Nitrogen |
|---|---|---|---|---|---|---|---|
| C ......... | 8 | 0 | †175 | 0 | 500 | 500 | 177 |
| E ......... | 8 | 0 | †175 | 0 | 250 | 250 | 102 |

*Fertilizer, 15% nitrogen (6% nitrate, 6% sulfate, 3% organic).
†Nitrate of soda.
Experiment planned by R. S. Thurston and J. A. Verret.

*Progress:*

Oct. 1918—All plots received, by mistake, 175 lbs. nitrate of soda, in irrigation water.
Feb. 4, 1919—First fertilization.
June 6, 1919—Second fertilization.
April, 1920—Experiment harvested by J. H. Midkiff.

## *Grove Farm Experiment No. 5 (1920 Crop).*

### Fertilizer Experiment—Forms of nitrogen.

*Object:*

To compare the value of equal amounts of nitrogen from: (1) Organic; (2) nitrogen mixture.

*Location:*

Field 6.

*Layout:*

Number of plots, 30.

Size of plots, 1/10 acre each (48.3′x90.2′). Plots one water course wide and rows irregular.

*Plan:*

FERTILIZATION — POUNDS PER ACRE.

| Plots | No. plots | Fertilizer | Aug. 1918 | Oct. 1918 | No. plots | Aug. 1918 | Oct. 1918 | Total Lbs. Nitrogen |
|---|---|---|---|---|---|---|---|---|
| A ......... | 14 | N. mixture | 250 | †175 | 250 | 250 | 250 | 150 |
| F ......... | 8 | N. mixture | 1000 | †175 | .... | .... | .... | 150 |
| G ......... | 8 | Blood | 1250 | †175 | .... | .... | .... | 150 |

†Nitrate of soda.
Nitrogen mixture = 15% nitrogen (6% nitrate, 6% sulfate, 3% organic).
Dried blood = 12% nitrogen.
Experiment planned by R. S. Thurston and J. A. Verret.

*Progress:*

Sept. 22, 1918—First fertilization.
Oct. 1918—All plots received, by mistake, 175 lbs. nitrate of soda in irrigation water.
Dec. 17, 1918—Second fertilization.
Feb. 4, 1919—Third fertilization.
June 6, 1919—Fourth fertilization.
April, 1920—Experiment harvested by J. H. Midkiff.

J. A. V.–R. S. T.

# Plantation Rehabilitation.

By Donald S. Bowman.*

One of the great problems that confronts the sugar estates today is the completion of the rehabilitation program which has been under way a number of years. Much has been done to ameliorate conditions, and this has no doubt increased the efficiency of the labor and produced a greater general feeling of contentment in so far as living conditions are considered. The complicated growth of the social and industrial relations of this Territory makes some form of paternalism inevitable. We are duty bound to protect the general health and well-being of our imported labor. This fact has been long recognized, leading up to the splendid system of housing and sanitation in force today, which, if continued, will place us in a few years in the front rank of industries that maintain ideal housing conditions, thus placing the plantations in such a position that the industrial housing laws of the United States will have been complied with. The Industrial Service Bureau's Sanitary and Building Code, together with the general recommendations, if followed, complies quite fully with the "standards recommended for permanent industrial housing developments" by the Department

*Industrial Service Bureau, H. S. P. A.

of Labor, U. S. Government. It is quite evident that the Department of Labor will soon have general jurisdiction over industrial housing. The work of the Bureau of Industrial Housing, created by the Department of Labor in June, 1918, under whose directions some $100,000,000.00 was expended for general community utilities and housing of government employees in arsenals, navy yards, etc., met with marked success, and the completed villages were in every way far superior to those undertaken by private corporations who had expended the same amount of money without careful consideration of the ultimate outcome and without obtaining proper advice on village planning. This comparison has done much to awaken in the minds of those interested in industrial housing the need of governing laws.

The building of new dwelling houses is not the greatest problem we have, as plans are at hand and new material can be easily handled. The difficulty arises

Type of one-family house (Plan 11) now under construction to replace barracks being removed. These attractive houses will face on a macadam road, and be provided with sufficient yard and garden space.

when we consider reconstruction—what buildings may be made to answer modern requirements—how to get away from the open-fire smoke-box kitchens and provide an economical, practical kitchen, well ventilated, free from smoke, etc. The disposal of waste water and fecal matter is another vital problem, and this cannot be accomplished without some labor and expense; but the returns in cleanliness, comfort, and health make an intelligent expenditure of labor and money for such a purpose one of the best possible investments.

More attention should be paid to the rebuilding and grouping of the houses. This can best be cared for by making a careful survey of the camp and planning all improvements in advance, in order that the completed work will be harmonious in the whole. A careful survey will no doubt show that many of the old buildings can be reconstructed, while others will have to be demolished entirely. The principal points to consider in the rehabilitation of a camp are: dwellings that meet with the requirements of the building code, laws and standards, as to construc-

tion and location; outhouses that are sanitary and convenient; drains and sewers that are sanitary and practicable for plantation use; water supply that is safe. The general layout of streets, drains, etc., as well as the location of buildings, should receive careful consideration.

A careful study of these and other problems that confront the plantation manager in his consideration of rehabilitation has been made by the Industrial Service Bureau, who are prepared to assist with plans, suggestions, etc.

Old plantation camp undergoing rehabilitation; barracks and shacks being removed; two-family houses remodeled. New type dwellings may be seen on extreme right. Space in center of camp now in cane to be devoted to gardens.

A housing survey of one plantation brings to light the fact that ninety per cent of the dwellings are of good construction, provided with the proper light and ventilation, but owing to a bad type of detached kitchen and many lean-tos added by the laborers, most of the dwellings have a decidedly dilapidated appearance, but they are not beyond recall when it comes to remodelling.

## Protecting Boiler Drums From Overheating.*

A bulged spot on a boiler shell is not an uncommon occurrence. We associate it usually with the fire sheets of horizontal tubular boilers, the crown sheet of locomotive boilers, and in general with the furnace tops of internally fired boilers. The cause may be either shortness of water or an accumulation of oil, mud, or scale. When a steel plate or a steel tube is exposed to the hot products of combustion on one side, and is covered with water on the other side in a well-

*Reprinted from *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company in *The Boiler Maker,* March, 1920.

designed boiler, heat is transmitted from the hot gases and from the radiating fuel bed through the metal to the water at a sufficiently rapid rate to keep the temperature of the metal well below the range at which it begins to lose its strength and become soft and plastic. If, however, some substance comes between the metal and the water which cannot remove the heat from the metal as fast as it is received from the fire and the hot gases, the metal becomes gradually hotter till a point is reached at which it is no longer able to withstand the stresses imposed by the steam pressure within the boiler and the plate or tube swells out into a bulge. If the bulged metal continues to receive heat at a faster rate than it can dispose of it, the bulge increases in size and the metal wall gets thinner and thinner until it ruptures at the weakest point.

### Common Causes for Bulging.

There are many different conditions which may result in a bulged spot in a boiler, and, since the portion of the boiler directly exposed to the action of the flame and combustion products is usually below the normal water line, we are apt to look for this condition only at such points. The most common cause for bulges below the normal water line of a boiler is, of course, a deposit of some sort of heat-resisting material on the water side of the metal. This may be an oil film or it may be a deposit of mud or scale matter from the boiler water. In either case if it provides sufficient hindrance to the flow of heat a bulge will result. Another common cause for the bulging and rupturing of boilers is found in some abnormal working condition which permits the water line to become dangerously low. Under these circumstances as soon as steam and not water covers the surface of metal exposed directly on the opposite side to the heat of the products of combustion, overheating of the metal, which will result in bulging and rupture, is likely to start, because heat cannot flow as readily through a metal and into steam as it can flow through the same metal and into water.

### Superheating Surface.

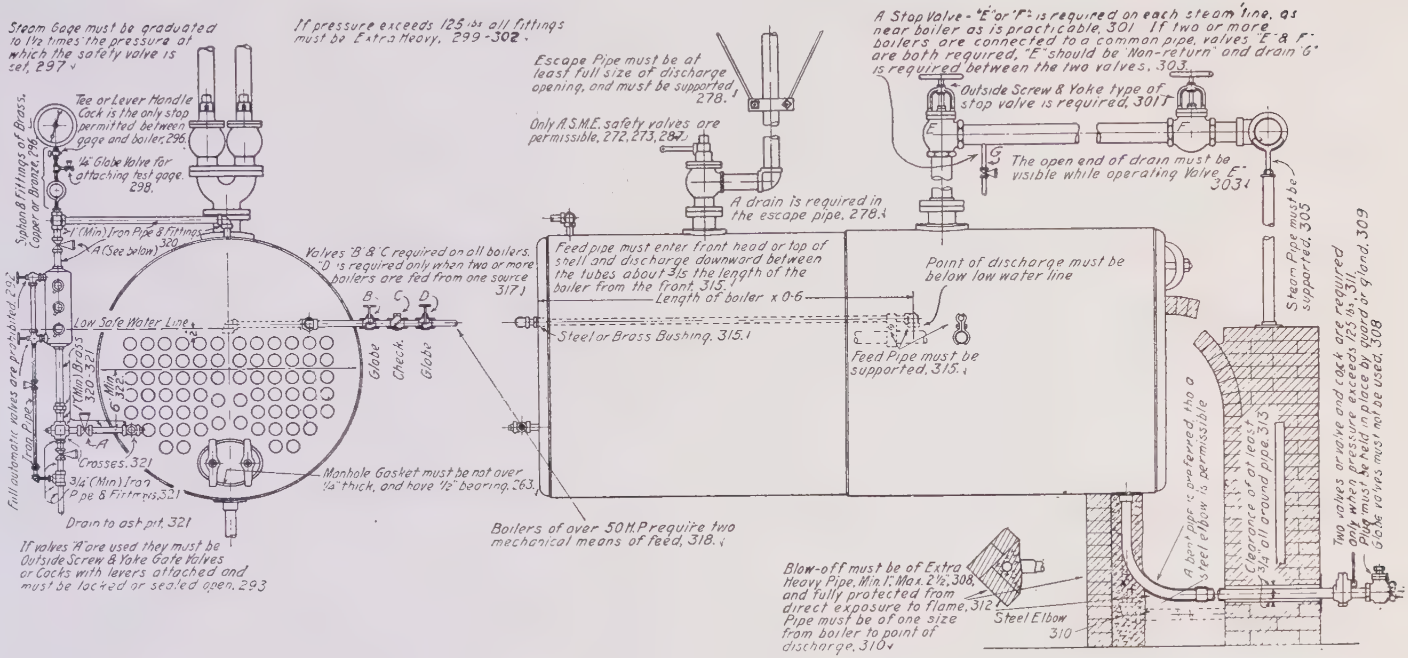
To be sure, superheaters are made in various ways with special provisions for the rapid absorption of heat by the steam and for considerable reserve strength to resist the tendencies to bulge on the part of the metal, in which heat can be safely and profitably transmitted directly from the hot gases to steam through the metal. It is also true that a properly designed vertical firetube boiler may have a portion of the upper end of the tubes exposed on the one side to the steam and on the other to hot gases with no serious results. In general, however, a portion of a shell or drum of a boiler, whether of the firetube or watertube type, which is exposed to combustion products on one side and is not covered by water on the other side is apt to prove troublesome, if not dangerous.

### Three-Pass Setting.

Formerly it was common in some parts of the country to return the gases from an ordinary horizontal return tubular boiler from the front end after they had passed through the tubes directly back across the top of the boiler in a brick

# BUREAU OF BOILER INSPECTION.

Minimum requirements for newinstallations of horizontal return tubular boilers and suggestions for safety for present installed boilers.



flue of which the upper surface of the boiler shell was a floor, to a stack connection at the back. This arrangement has been known locally as a three-pass setting. It probably succeeded in running without serious injury to the boiler (when it did so succeed) chiefly because the gases were pretty well cooled before they emerged from the tubes at the front end, and also because as the boiler shell formed the bottom of the third pass it must inevitably become heavily blanketed with soot and fine ash in an exceedingly short time. Soot and ash are rather better insulators to heat flow than many forms of pipe covering, and so the top of the shell usually became protected with soot. When it is remembered that if soot enough was deposited on the boiler top to protect the shell plates there would certainly be enough of it to practically prevent any possible economy through the additional absorption of heat from gases by the steam. Also, since the supposed extra absorption of heat was the only reason for providing the extra gas pass, a matter of some expense and much inconvenience, as such a pass greatly complicates the provision of proper and accessible manholes and the location of a safety valve close to the boiler shell, there is no great difficulty in seeing why its use is rapidly declining even in the regions where it had become a nearly standard method of installing boilers.

## The Protection of Boiler Drums.

When horizontal tubular boilers are set, care is taken that the brick work of the settings shall come close enough to the boiler shell so that the joints can be tightly packed with asbestos rope. The line at which the brick setting and the shell are joined through this packed joint is about where a horizontal plane through the horizontal diameter of the head would cut the shell, and this is several inches below the usual working water line. In the event of low water, several rows of tubes would be exposed to the fire before any unprotected portion of the shell comes in contact with hot gases. However, in some sorts of watertube boilers the settings are so arranged that parts of the space open to the gases are in contact with portions of the surface of steam drum, which are not always covered with water on the steam side. This condition may be aggravated at times of heavy load by the fact that the water line is not uniform throughout all parts of a watertube boiler, but may rise, due to the effect of the rapid circulation in some of the tubes and drums or in some portion of the boiler, only to correspondingly fall at other points. The amount of this rise and fall varies with the rapidity of the circulation and the load on the boiler. A further condition to be reckoned with is the fact that, although where the rate of combustion is moderate and the furnace conditions good, combustion may be completed long before the gases reach the relatively out-of-the-way corners where the shell surface is exposed above the water line. Still, under overload conditions, or with poor firing, an entirely different set of circumstances may arise.

## Secondary Combustion.

It is not uncommon for a portion of the fuel bed to give off combustible gas in a solid stream at a rapid rate. This solid stream may easily pass through a considerable part of the combustion space without burning. It will do this,

for example, if it is not properly mixed with air; for gas cannot burn without air, no matter how hot the surroundings. If such a stream of hot combustible gas gets up into the corners of the setting and there finds air which is perhaps leaking through small cracks in the brick or tile, it will often burst into flame and burn strongly at these points, notwithstanding that it has come a long way from the main part of the fire. Such burning of combustible gas when boilers are being forced on coming in contact with air is the thing which is occasionally seen as a flame at the top of the stack, especially in the case of gas retorts and foundry cupolas, and is known as secondary combustion. It should be clear that if secondary combustion occurs in a corner of a boiler setting alongside of a portion of the boiler shell and above the water line, serious and perhaps dangerous bulging of the shell is the result to be expected, probably also followed by a more or less violent rupture. Indeed, such a rupture might easily be sudden and large enough to start a boiler explosion, for, once released, there would be abundant energy stored in the hot water and steam within the boiler to continue the destruction.

### The Obvious Cure.

In any case, even if the rupture were a small one, resulting only in the gradual release of the steam from the boiler, the accident would prove inconvenient and expensive. The means for preventing such accidents is simple and should be obvious. It consists merely in carefully studying the setting of a boiler to see if it is possible that the water line in ordinary operation can drop low enough to expose portions of the shell unprotected by water to the gases. If this is possible the setting should be changed immediately so that this contact will become impossible. [W. E. S.]

## Superheated Steam.*

By Gustavo Lobo.†

The article on the subject of superheated steam which appeared in your issue of January 3 should be of great interest to sugar factory engineers and owners, and the writer certainly has brought out in concise form the principal advantages of superheat in this type of plant.

There is one point, however, touched upon in your article which, I believe, could be somewhat amplified so as to bring out its great importance. I refer to the decided advantages of the use of superheated steam in an electrified sugar mill—that is, one operated electrically and with a central electric generating station in which are installed steam turbo-generators.

In addition to the value of superheated steam as a means of increasing the

*Facts About Sugar, March 13, 1920.
†President of the Kelvin Engineering Company.

efficiency of the turbine, with the consequent reduction of the cost of power and of furnishing a drier exhaust for use in the heaters and evaporators, attention should be called to the great value of superheated steam in diminishing or avoiding completely the wear of the turbine blades, due to entrained moisture.

If for nothing else, the use of superheated steam in turbines would be worth while for this reason alone, as erosion of blading is almost entirely done away with, the maintenance cost of the turbine very greatly reduced, and the possibilities of breakdown from that cause practically eliminated.

As a result of the experience of several years in the construction and operation of electrified sugar factories, I can safely say that there have been no troubles or shut-downs due to blade wear in factories where superheated steam is used, whereas in those factories which have been using dry saturated steam there have often been difficulties, and even at times lengthy shut-downs, due to the wear occasioned by the moisture in the steam.

In regard to the increased efficiency due to the superheat, I would say that this is corroborated by the guarantees offered by the turbine builders, whose specifications stipulate that the efficiency of the turbines will be increased two per cent for each one per cent of moisture which is eliminated from the steam.

[R. S. N.]

# The Yellow Stripe Disease.*

*A Report of an Investigation Into Its Prevalence in Porto Rico.*

By Noel Deerr.

## Early History of the Disease.

As far back as the beginning of organized research in Java about 1895, a condition known as yellow stripe was recognized. The botanists there have never treated the condition as a specific disease, but have regarded it as a sporting tendency possessed by the cane, that is to say, they believed that the cane had the habit of throwing leaves deficient in chlorophyll. They recognized the inheritance of the condition in so far that it was observed that cuttings taken from canes which had shown the yellow stripe tended to give a crop with a greater percentage of yellow striped canes and that when cuttings from unaffected canes were used the condition tended to disappear. Experiments made in Java negatived the presumption that the disease was infectious, or that it was caused by any specific organisms.

About 1909 Dr. H. L. Lyon, the plant pathologist attached to the Experiment Station of the Hawaiian Sugar Planters' Association, made an extended tour of investigation through Australasia and Java for the purpose of gaining information on cane diseases and kindred matters at first hand. He recognized that the

*Facts About Sugar, Vol. X, Nos. 10, 11, 12.

yellow stripe condition also was present in Hawaii and on his return he instituted a series of experiments. Contrary to the Java experience, he found that the disease was infectious. He also determined the loss due to the disease in a large number of varieties, examined the susceptibility and resistance of the same and advised, as a means of control, seed selection and the rejection of those varieties found to be susceptible, independent of any other desirable features that they possessed. In addition the introduction and exchange of seed cane from areas known to be infected was discountenanced. I believe that it was due to the early recognition of the possible danger of the disease that the Hawaiian Islands were saved from such an epidemic as is now prevailing in Porto Rico. Nevertheless the latest advices I have from Hawaii indicate that the disease is slowly gaining, especially in one district where conditions seem to be favorable to its development.

## Identity of the Disease.

The manifestations of the disease being so different in Porto Rico from what they have been in Java and Hawaii has led to doubt as to their identity. Of this there seems to be no doubt whatever, as the published descriptions from Java are in so great detail and correspond exactly with the lesions that are observed in Porto Rico, the difference being in extent only. This point has been discussed in full detail by Mr. Colon, in one of the publications of the insular station. The reasons for the different behavior of the disease in Porto Rico will appear from remarks that follow later.

Plantation Practice in Java as Differing From That in Porto Rico Considered in Relation to the Yellow Stripe Disease: The peculiar methods used in Java in plantation routine undoubtedly have protected the industry there, and as these bear on the condition in Porto Rico, some mention of them is apposite. In Java substantially all cane grown is planted cane, and cane is only grown on the same land at the most one year in every three, the land during the other two years being under rice and ground provisions. In such a system any organism parasitic on the cane is denied its host for two years out of three, and must therefore tend to disappear for lack of a suitable habitat. With the system common in Porto Rico (and elsewhere) of cane following cane, any parasitic organism has a continuous habitat, and not only does it have the opportunity of increasing in number, but it is also afforded the opportunity of developing a strain specifically virulent to the host plant.

A second control factor is the system that has developed in Java of growing seed cane in mountain nurseries remote from plantations and so removed from any source of infection. This system was originated as a means of controlling the "sereh" disease, and doubtless, though not of intent, has been equally adequate in preventing the spread of the yellow stripe.

Thirdly, I believe that in the selection of new seedling varieties in Java attention was paid to the appearance of yellow stripe considered as an undesirable feature, so that while the new Java varieties probably are not immune, they are resistant and not liable to be severely affected by the disease.

These differences in routine, accompanied by the extraordinary care used in Java in inspecting each cutting used for seed (a process possible with the exceptionally cheap and abundant labor), fully account for the differences observed

between Java and Porto Rico, and at the same time suggest a basis for methods of control, some of which have already been put into application.

## Introduction Into West Indies.

There does not seem to be any doubt but that the disease has been only recently brought into the West Indies. No one of the many older planters whom I met had any recollection of seeing the disease previous to 1916, and hence it is very probable that the disease has been imported along with some recently introduced varieties. Amongst these are a number of varieties recently brought from the Argentine through, I believe, the agency of the United States Department of Agriculture. These varieties include some Java seedlings brought to the Argentine by way of Egypt, and the yellow stripe disease now known to be prevalent in the Argentine is also known to be of recent occurrence in Egypt. In addition, Mayaguez seems to have been a focus of infection and both Fajardo and Guanica were of opinion that the primary infection on these properties came with seed cane from the federal station.

It was in 1914 that these importations were made, and at first sight the rapid spread of the disease seems to have been remarkable. It is, however, an established fact with disease of all types that a parasite introduced into a locality where it has not been previously present often develops a fulminant form. This phenomenon is explained by the faculty possessed by living organisms of developing immune strains, thus forming an example of the general principle of the "survival of the fittest." Under this conception the stock in Java, where the disease has been long established, may be regarded as having produced more or less resistant types, due to the elimination of susceptible strains. In Porto Rico, however, where the disease has not been present, there will have been no opportunity for the weeding out of susceptible strains, so that the introduction of a parasite will be likely to be followed by an epidemic.

## The Position of Cuba.

The introduction to Cuba may also be ascribed to similar importations but of these I have no exact knowledge, only knowing that such have occurred recently.

Dr. E. W. Brandes, in Bulletin 829, U. S. Department of Agriculture, states that the disease has been present in Cuba for at least twenty years. He mentions Santiago de las Vegas and Cienfuegos as the localities where it is most prevalent, and to these I can add Jobabo, where I recognized the disease as appearing sporadically in isolated areas in 1915. It is very remarkable that the disease has become epidemic so rapidly in Porto Rico, while up to the present there is no report of an epidemic stage in Cuba. This cannot be attributed to immunity, since the crystalina cane planted everywhere in Cuba has been found to be very susceptible in Porto Rico. Possibly the explanation may lie in the lack of extension of the introduced varieties, since nearly the whole of Cuba is planted with "native" stock and the introduced varieties have been but sparsely applied.

At the same time it is to be remembered that the means of transmission of the disease is as yet unknown, and there may be some factor present in Porto Rico which is absent in Cuba.

## Cuban Situation Dangerous.

Although I have not been in Cuba for three years, I wish to go on record as stating that the presence of the disease there should be treated as a source of danger, and specifically I would say:

(1) It should be recognized that the disease exists in Cuba in widely separated localities, but that it has not yet reached any great extension.

(2) Judging from previous experience a rapid spread of the disease *may* at any time occur.

(3) The widest publicity should be given to the facts in such a way as to advise of the danger, while at the same time avoiding any tendency to panic.

(4) All interested parties should be on the alert to detect the first symptoms of any outbreak of the disease, and when any such appears the system of eradication advocated by Mr. Earle should be applied.

(5) Unless the disease has made much more headway than the reports to hand lead me to believe, I think that the situation can be handled, provided the lessons to be learnt from the situation in Porto Rico be not neglected.

## Extent in Porto Rico.

The itinerary I followed in Porto Rico took me over a great part of the cane areas and it was a matter of easy observation to see that nearly the whole island is infected. The lands controlled by the Fajardo Company are nearly if not quite free from the disease, and up to the present it has made no great progress at Aguirre. Otherwise wherever I went the disease was thoroughly established. This includes the south coast, west of Aguirre, the west coast, the line running north from Ponce to Arecibo, and the north coast up to and including the lands controlled by the Loiza Sugar Company where the disease is of very recent appearance amongst the colonos' cane.

Indeed, the only extensive areas I saw free from disease were the lands of the Fajardo Company, and here unfortunately some cane belonging to independent growers, such as that at Maizalles, and contiguous to Fajardo fields is very badly infected. A similar focus of infection was shown me by Mr. Carpenter at Cortada where a badly infected field belonging to the Santa Isabel Company abuts the fields planted by Aguirre. This interlocking of properties forms a serious factor in the control of the disease, and is all the more serious where there happens to be a number of small planters of less intelligence, since it seems quite possible that these scattered small infected areas may be a factor of importance in determining the secondary infection of other areas planted from disease free seed.

## The Effect of Climate.

Before leaving New York for Porto Rico I had learned that the years 1917 and 1918 had been deficient in rainfall. It had also been suggested that the remarkable decrease in output as between the years 1917, 1918, and 1919 was mainly due to the drouth and that the effect of the disease had been exaggerated.

I, therefore, obtained the statistics of the United States Weather Bureau and collated these as regards the northern and western districts, where the dis-

ease had been known to have been severe. These data are to be found in the appended exhibit and you will note:

NON-CONNECTION OF CLIMATE AND OUTPUT

Rainfall and Crops in West Porto Rico

| | | | | |
|---|---|---|---|---|
| Year | 1915 | 1916 | 1917 | 1918 |
| Number of rainy days | 110 | 144 | 159 | 149 |
| Inches rain | 76.6 | 80.2 | 78.4 | 76.4 |
| Year | 1916 | 1917 | 1918 | 1919 |
| Tons of sugar produced* | 27,508 | 32,405 | 21,896 | 19,632 |

*From Centrals Rochelaise, Ana Maria, Corsica, Eureka, selected as known to be affected by the disease.

Rainfall and Crops in North Porto Rico

| | | | | |
|---|---|---|---|---|
| Year | 1915 | 1916 | 1917 | 1918 |
| Number of rainy days | 188 | 191 | 180 | 175 |
| Inches of rain | 82.8 | 89.0 | 71.8 | 63.9 |
| Year | 1916 | 1917 | 1918 | 1919 |
| Tons of sugar produced* | 84,271 | 77,509 | 62,516 | 50,244 |

*From Centrals Cambalache, Los Canos, Cayey, Monserrate, Constancia, Carmen, San Vicente, Alianza.

The crops at Centrals Vannina and Canovanas, also lying in the North Coast climatic zone, but known to be little affected with disease, were:

| | | | | |
|---|---|---|---|---|
| Year | 1916 | 1917 | 1918 | 1919 |
| Vannina | 10,464 | 10,543 | 12,135 | 11,733 |
| Canovanas | 16,313 | 14,706 | 15,413 | 15,184 |

The total crops of the island were for these same years:

| | | | | |
|---|---|---|---|---|
| Year | 1916 | 1917 | 1918 | 1919 |
| Tons | 483,589 | 503,081 | 453,795 | 406,002 |

I am informed that there was a small but distinct increase in the acreage reaped from year to year.

(1) That the rainfall on the north coast for the years 1917 and 1918, correlated with the crops of 1918 and 1919, was very deficient and coincided with a reduction in output.

(2) On the other hand, for the same years the rainfall on the west coast was normal and the falling off in yield was similar to that on the north coast.

I discussed this question with Mr. Latimer at Cambalache and he was most decidedly of opinion that though some of the loss was due to the dry weather, yet by far the greater part was due to disease. As a specific instance of this he referred me to certain fields in a small irrigated section, and so without the influence of climate, where the fall in output, due entirely to disease, was very great.

In addition at Centrals Vannina and Canovanas, also within the north coast climatic zone, the crops showed little variation and in the areas tributary to these centrals the disease has not yet become extensive. Complete data as to acreage reaped, etc., which should appear to make the comparison complete, were not available; the inference to be drawn, however, is not invalidated by their absence.

I was also told by Mr. Latimer that much of the decreased output of Cambalache:

| | | | | |
|---|---|---|---|---|
| Year | 1916 | 1917 | 1918 | 1919 |
| Tons | 23,443 | 23,129 | 15,197 | 11,021 |

was due to colonos giving up in despair and leaving their fields uncut. He estimated the difference in tonnage in his worst attacked fields as roughly a reduction from a normal return of 25 tons to one of 17 tons per acre. This proportion is very similar to what Mr. Todd gave me as obtaining in severely infected fields at San German and Anasco and which he ascribed as due solely to disease and not to climatic variation.

It has also been suggested that following on the exaggerated price of raw sugar much land unsuited for cane has been put into cultivation in 1914, 1915, etc., and that the fall in production was in part at least due to the failure of these lands to ratoon properly.

Though without doubt much land that in normal times would not have been planted to cane has been brought into cultivation, I do not think that this planting can be correlated with the fall in production, or in any way connected with the disease. All over Porto Rico wherever I went the disease was just as prevalent in lands known for their fertility as it was in poorer soils. Indeed, it was in the Arecibo Valley, which appealed to me as the finest stretch of cane land that I saw in Porto Rico, that the disease first appeared and where the infection was most severe.

## Root Disease and Yellow Stripe.

A suggestion has been made that the yellow stripe is merely a manifestation of root disease, and I looked into this point very carefully.

In Porto Rico areas can very commonly be found in which are stunted canes, and on examination of the basal portion of the stalks there can be found evidence of one or other of the various organisms to which the condition known as root disease is due. While, however, root disease and yellow stripe may be present on one and the same field and on one and the same stool, observation soon showed that the typical lesions symptomatic respectively of yellow stripe and of root disease occurred quite independently of each other and that there was no connection between the two conditions. Indeed, in the form in which yellow stripe occurs in Porto Rico the mottling of the leaf and the eventual appearance of the internodes in cases of severer attack are easily distinguished from the stunted growth and shrivelled dry leaves of such stools as have been attacked by root disease. This appearance on the whole simulates that produced by a severe drouth.

## Observations in Tucuman.

In the case of canes attacked by root disease there is, however, often a yellowing of the leaf but the appearance is quite distinct from that due to the yellow stripe. This yellowing has quite recently been studied by Cross in Tucuman, who has shown that the application of soluble nitrogen will restore the vitality of the stool and renew the green color of the leaf. The appearance due to this condition and the effect of soluble nitrogen is thus described by Cross:

"In the Spring of the year 1918-19 there was observed in this province a considerable extension of newly sprouted cane, which, as a result of the attack of root disease, became yellowish, almost white in color, and remained more or

less stationary in its growth until it was able later on to overcome the disease, when it became green again and at the same time renewed its growth. Seeing that the chlorosis of the cane is due to want of nutrition caused by the destruction of many of the roots, it appears logical that the cane could overcome the disease more readily if it were strengthened by applications of soluble nitrogen fertilizer immediately available. To investigate this possibility it was resolved to carry out experiments in two lots of the experiment station containing Zwinga cane which was suffering greatly from the disease in question.

### Results of Experiments.

"In the first lot, sulphate of ammonia was applied to certain rows, and Chilean nitrate to others, both of these fertilizers being immediately soluble. Other rows in the same lot were not fertilized. The fertilizer was applied at the rate of 6 kilos to a row of 100 meters, on the 8th of November, that is to say, just at the time the cane was suffering most from the disease. In a few days a considerable improvement took place in the fertilized cane, which recovered completely and took on the deeper green color a long time before the non-fertilized cane."

This experience is in line with that of Mr. Gray at Soledad, and I suggest that possibly there may have been some confusion between the two conditions.

As a further explanation of the results observed by Mr. Gray I would suggest the possibility of a double infection with both root disease and yellow stripe, for in such a case the interpretation of the results obtained from an application of soluble nitrogen would be likely to be very confusing.

### Nature and Course of the Disease.

The disease has all the earmarks of being caused by some parasitic microorganism, though up to the present there has been published no account of any such as associated with the disease. On the day that I left Porto Rico I was, however, asked to see the work that has recently been done by Mr. Metz at the insular station. Mr. Metz showed me preparations indicating that he had isolated in both leaf and stalk, and residing in the interior of the parenchyma, an organism presumably connected with the disease. Mr. Metz gave me leave to refer to this matter in any report that I might make, though, of course, until he makes some statement himself he is in no way committed.

Although the disease is essentially a leaf disease, the presence of the presumptive causal organism in both stalk and leaf may account for certain contradictory experiments that have been made:

(1) In some cases, as at Vista Alegre (Fortuna) a plot planted with seed taken from infected stock came up sound. If here the infection had been confined to the leaves only the anomalous result is accounted for.

### An Awkward Question.

(2) Experiments the reverse of the above were shown me, where seed cane apparently healthy gave an infected stand, even from the first. In this case the parasite may have been present in the stalk without the latter showing any out-

ward sign of the disease. I believe that this has occurred in a number of cases, since in many cases it is impossible to determine if a cane is infected or not when once the leaves have been removed. This presumptive evidence of the parasite in the interior of the stalk is then a very awkward feature in the control, since it adds very materially to the difficulty of obtaining sound seed of assured freedom from infection.

What appeared to me, however, as a great difficulty in the control of the disease was the frequency and rapidity of the secondary infection—that is to say, the appearance of the disease in fields planted from sound cane. In many such cases the cane comes up quite sound and continues to do so up to the age of about two months, when the disease appears, not in the oldest leaves, but in those just beginning to unroll. This infection is continuous and progressive, since it is common to see in standing cane many stools with all the lower joints sound but with those in the upper third exhibiting the characteristic symptoms of the disease and with the leaves still attached to the green top heavily infected.

This secondary infection is at times very rapid and from what I gather from Mr. Todd at Guanica it has appeared there so rapidly and extensively as to prevent the rogueing out of infected canes, as has been done so successfully at Fajardo and other places where the disease last appeared and after its nature and danger were understood. A second example of this secondary infection was afforded me by Mr. Latimer, who told me that in the early period of the epidemic the imported seed came from Ponce, where at that time the disease was unknown. Fields at Cambalache planted with this seed came up sound, but rapidly became infected and as diseased as the rest of the district.

## Study of Infection Important.

It would appear to be of great importance to study the mechanism by means of which this secondary infection obtains. A lot of work has already been done and at one time insects were suspected of being the carriers, but experiments made to test this hypothesis have up to the present only afforded negative results. Soil infection also seems to have been eliminated, but I hope that the experiments now being carried on by Mr. Metz will soon lead to positive results.

In the worst infected districts it was not uncommon for colonos to abandon their fields and to leave them unreaped. This I consider a most dangerous practice, as these fields can form nothing else than foci of infection to the surrounding areas.

I would also offer as a suggestion that certain phases of the disease seem to point to there being other host plants than the cane, which serve as reservoirs for the parasite whence it may be conveyed by agencies such as the wind to other fields. Such host plants might be wild grasses, growing on the cajones and in nearby pastures. Without such causes it is hard to see how a field plowed under, planted to cow peas, and planted to cane after the peas have been plowed under, could become so rapidly infected as has often been observed at Guanica. That such a means obtains in other plant diseases is well known, and in some cases the presence of a secondary host is essential.

## Control of Disease.

A great deal of very painstaking work has already been done to this end, and it has been mainly concerned with seed selection, rogueing out and with the planting of immune varieties or rather with those that are either resistant or tolerant to the disease. These and some other methods are discussed below.

Seed Selection: While it has been definitely shown that the plant of sound seed gives a healthy stand, the presence of secondary infection very much complicates the matter, though in the absence of the latter this would afford a complete control. In certain localities the infection is so wide spread that it is a matter of difficulty to obtain sound seed in quantity or to know that seed apparently sound is not infected. In such a case I would be rather inclined to select by fields (*i. e.,* use for seed cane from those fields known to be least infected) rather than to attempt to select sound seed from the diseased areas. I would also suggest the possibility of establishing seed nurseries in localities remote from the cane areas, provided there is any land available for this purpose. This suggestion will be recognized as borrowed from Java practice, where it was established as a means of controlling the "sereh" disease, and is one that has now become there a matter of routine. Quite possibly it has also unconsciously helped there in anticipating any outbreak of yellow stripe. How such a scheme will be applicable in Porto Rico can be best decided by those familiar with local conditions.

Rogueing: While it has been definitely established that this means will, when properly applied as soon as the infection appears, prevent the spread of the disease, there is so much of Porto Rico now infected that I believe this means can only be used to prevent the spread of the disease in those areas that still remain free. In certain parts rogueing would almost mean the uprooting of the whole planting, and in certain cases I was led to believe that the infection did not go so much from stool to stool as that it was introduced from external sources.

## Rotation of Cane Areas.

Decrease of Ratoonage: It has been found that the disease increases the longer the same planting is allowed to occupy the land and therefore at Guanica by this time 75 per cent of the total area is under plant cane. This is, I take it, only a temporary expedient, since under normal conditions such a routine would prove far too expensive.

Intermediate Crops: The system of green soiling with cow peas that is now in common use should certainly afford a means of diminishing the extent of the disease, but even so at Guanica several instances were shown me where fields so treated became heavily infected after planting and after coming up quite sound. While on this subject I cannot help referring to the faultiness of that system of agriculture which maintains continuously on the land but one crop and to this system I am inclined to attribute the frequency with which cane crops have been in times past attacked by epidemics of disease. Under present conditions I cannot suggest any other alternating crop for use in Porto Rico, but the matter is one that should have attention.

THE TREATMENT OF TRASH: I gathered that in Porto Rico cane is never burnt before cutting, and that the trash is always allowed to remain and rot on the fields. As an agricultural practice this system is absolutely correct and the practice of burning off crop residues should be condemned. In some other localities devoted to cane cultivation it is both customary to burn before cutting and to burn off the trash which remains on the fields. It appears to me that there might result a diminution of the disease if such a routine were adopted as a temporary expedient in Porto Rico, especially in those areas that are infected with the disease. Possibly the adoption of this routine has had some effect in protecting the Hawaiian Islands from an epidemic such as has occurred in Porto Rico.

## SPRAYING OF CANE SUGGESTED.

SPRAYING: It did not occur to me to discuss this means of fungus control while in Porto Rico, and even now I hesitate to introduce it lest it be thought altogether too impractical. Spraying with bordeaux mixture or with lime sulphur washes is usually only applicable to crops of great intrinsic value, such as fruits and vegetables, and I do not think that it has been applied to extensive areas such as the cane except in one instance. Some years ago the Olaa plantation in Hawaii put into operation a system of arsenical sprays as a means of weed destruction, that plantation being most notoriously infected with weeds and grass. The problem of cheap application was solved by the use of animal-drawn tanks through the fields. The cost of application was found to be 65 cents per acre per plantation, including the cost of the spraying mixture, one man and one mule taking care of from three to five acres per day.

I do not lay much stress on this suggestion and at best it could be applied to young cane only, and as a means of preventing the secondary infection.

It might be objected that as the parasite resides in the interior of the leaf, spraying would necessarily be inoperative. I believe, however, that in the secondary infection the parasite enters from outside and possibly gains access to the interior of the leaf through the stomata. Spraying cane would then be comparable at this stage to spraying as used to prevent the attacks of rusts and other organisms that have their habitat on the exterior surface of the leaf.

PLANTING OF IMMUNE VARIETIES: Without doubt this is the means upon which most reliance should be placed, and in the history of past epidemics it is the one that has proved most successful. Much progress has already been made in Porto Rico in this way, and following on the efforts of Mr. Earle and the observations that have been made at Fajardo and Guanica experiment stations, the most tolerant and resistant varieties available are now known and are being extended. Of the newer varieties D 117, D 433, G. C. 701, G. C. 1313, and G. C. 1486 appear to be much more resistant than are the Rayada, Crystalina and Yellow Caledonia that formed the bulk of the cultivation before. D 443 at present exists only in quantity at Fajardo, but it appeared to me to be a cane of great potential value. To these ought to be added Java canes J 56 and J 234, which seem to have been responsible for the introduction of the disease, but which are themselves resistant to it. (On this point compare the introduction of measles by Caucasians to the Hawaiian Islands, where amongst the natives it created a pestilence.)

### Kavengire Cane Immune.

The cane to which very much interest is to be attached is that known as Kavengire and which should be called Uba. This cane is certainly immune. Experiment has shown that it gives a very high tonnage and a juice about equal to that afforded by Yellow Caledonia. It is, however, a cane dissimilar in habit from other varieties and one likely to arouse prejudice. It has a high percentage of fibre and its stalk is covered with an excessive quantity of wax. Its juices are hard to defecate and because of the wax trouble arises at the filter press station.

This cane is, however, the only one extensively grown in Natal, where the production is now over 100,000 tons of sugar per annum, and so it cannot be regarded as an experimental one. A very full discussion of this variety appears in the Louisiana Planter of December 20, 1919, and to the analysis there quoted I would add that they refer to sub-tropical cane and that probably in the tropics there would be considerably more sugar than here indicated.

I am of the opinion that an extended trial should be given to this cane in those areas that are heavily infected with disease. After the disease is under control return would be made to the older varieties. [W. P. A.]

## Agricultural Progress in Louisiana.*

At the meeting of the Louisiana Sugar Planters' Association, on March 10, 1920, a committee on "Agricultural Progress" reported on different phases of the sugar industry in Louisiana. The following extracts from this report summarize points of special interest.

### Fertilization of Cane.

The application of fertilizers was greatly delayed, and with few exceptions fertilizers were not applied until the early part of June. The exorbitant prices and scarcity of commercial fertilizers prevented planters from making their usual applications. Tankage, bat guano and cotton seed meal were the most popular fertilizers used. In the parishes along the coast, shrimp dust and fish scraps were used by some of the planters, and from the results obtained, they class this material on a par with cotton seed meal. At first these refuse products were about the cheapest fertilizers on the market, but the growing demand has increased the price.

The reports obtained from plantations using tankage and bat guano show that very little good was derived by the cane crop from these fertilizers last year. On Catherine plantation in Iberville, Mr. Supple reports excellent results from mixtures of cotton seed meal and acid phosphate. A mixture of 200 pounds each per acre was used on stubble cane.

*The Louisiana Planter, March 20, 1920.

The application of filter-press cake was conducted throughout the sugar district. Planters are convinced of the value of this material as a fertilizer, and are taking time to apply it to their lands. There are many instances where lands that produced 20 tons per acre, produced 30 and 35 tons per acre after a liberal application of filter-press cake. It also has the same effect on corn, increasing the number of bushels per acre. The filter-press cake increases the fertility of the land for at least two or three years.

The use of stable manure is increasing every year, and efforts are being made to construct proper manure sheds and pits to collect the manure. The small planters are ahead of the large planters in the use of stable manure. As a rule the former take great pains to save all of the manure, and will oftentimes go to the trouble of buying manure from stables in neighboring towns. This manure is carefully applied to crops of cane and corn. Some of the large planters have purchased manure spreaders and are applying more manure than in former years.

In the Parish of Lafayette, Mr. Eug. Landry conducted a field test on sugar cane using stable manure. Two plots side by side were selected for the purpose, with uniform land and stand and both receiving the same preparation and cultivation. On one plot manure was applied at the rate of two tons per acre and the other plot was left without manure or fertilizer. The plot that received the manure gave an increase of 4.2 tons of sugar cane per acre.

The general practice in the sugar district in the application of fertilizers, is to fertililze only the plant cane. As a rule the land of the plant cane crop has been in peas, and has either received all of the crop or one-third of the crop as green manure. This gives a sufficient amount of nitrogen to easily take care of a good crop of cane. However, while the peas enrich the soil in nitrogen, no phosphoric acid is added, and as phosphorus is one of the essential plant food elements, cane crops on such lands, while they yield heavy tonnages generally, produce juices that are a little low in sucrose. On the Raceland properties in Lafourche, straight applications of acid phosphate at the rate of 200 pounds per acre to plant cane have improved the sucrose yield of plant cane crops.

In the fertilizer tests that were conducted for the Colonial Sugar Company and the Longview Sugar Company, comparisons were made between different fertilizers. Mixtures of nitrate of soda and acid phosphate gave a net profit of $91.14 per acre; nitrate of soda applied alone gave as high as $97.67 per acre; while tankage gave a net gain of $11.75 per acre. In another test a mixture of 254 pounds of nitrate of soda and 254 pounds of acid phosphate produced 8.3 tons per acre more than the unfertilized field, giving a net gain of $110.27 per acre.

Where comparisons were made between cotton seed meal and acid phosphate and nitrate of soda phosphate, the following results were obtained:

| Plot No. | Fertilizer per acre | Increase over check | Net gain per acre |
|---|---|---|---|
| 1 | 300 lbs. cotton seed meal<br>225 lbs. acid phosphate | 2.5 tons | $ 25.08 |
| 2 | 100 lbs. nitrate of soda<br>100 lbs. acid phosphate<br>200 lbs. cotton seed meal | 5.31 tons | 67.61 |
| 3 | 200 lbs. nitrate of soda<br>225 lbs. acid phosphate | 3.52 tons | 41.17 |
| 4 | 200 lbs. nitrate of soda<br>450 lbs. acid phosphate | 4.14 tons | 47.75 |
| 5 | 300 lbs. nitrate of soda | 8.30 tons | 111.76 |
| 6 | 100 lbs. nitrate of soda<br>200 lbs. acid phosphate<br>160 lbs. cotton seed meal | 4.00 tons | 47.97 |
| 7 | 100 lbs. nitrate of soda<br>225 lbs. acid phosphate | 3.06 tons | 38.45 |

In Lafayette Parish fertilizer tests were conducted with fertilizers as follows:

(a) Mixture containing 25 lbs. nitrogen and 36 lbs. phosphoric acid, per acre.

(b) Mixture containing 25 lbs. of nitrogen and 76 lbs. phosphoric acid, per acre.

(c) 300 lbs. and 10 tankage per acre.*

(a) gave net gain of $108.06 per acre.
(b) gave net gain of 91.26 per acre.
(c) gave net gain of 80.27 per acre.

Mixture (a) is the one recommended by the Sugar Experiment Station, which for the past four years has been giving excellent results at the station.

## Land Improvement and Soil Fertility.

During the past year, even with the bad conditions, there was quite a lot of interest displayed in the sugar district for improved methods. The questions of land improvement and soil fertility are receiving more attention. The old three-year rotation system which was so universally used is now gradually going out. The four-year rotation, which is replacing this system, showed up exceedingly well in the Parish of St. Mary, on the Burguieres plantations. This group of plantations, taking into consideration the year, produced fairly good crops of cane and corn; while neighboring plantations in the same section, using the old three-year rotation, made very poor crops.

The cow pea is gaining more and more ground as a green manure. The old system of pulling all of the vine for hay is being discontinued. A large number of planters are turning under all of the vines and growing their hay crops on

*Evident misprint. Meaning not clear.—(Editor).

lands unsuitable for cane, such as heavy black lands, headlands, lanes and levees. On Uncle Sam plantation, in St. James, all of the hay required for mules on the plantation was grown on 27 acres of land planted in alfalfa and 70 acres in red clover. This is giving more than enough hay for the mules, and Mr. Jacobs is so well satisfied that he has adopted the system entirely and is now plowing under all of the crops of pea vines. On the Godchaux properties, in Lafourche, all of the hay crops are produced on levees and lanes, and all pea vines are turned under. The same system is also in use on Southdown, in Terrebonne.

Cover crops of sour clover and red clover were planted on fall plant cane in the Parishes of West Baton Rouge, St. James, and Lafourche. This is a procedure that originated at the Sugar Experiment Station and is giving excellent results there. So far it is only being tried by a few of the planters of the State. However, the results attained at the Sugar Experiment Station justify a more extended use. The results show as high as four tons per acre increase in stubble cane the following year on plots where the clover is turned under, over plots where no clover crops are used.

Velvet beans are being used to a great extent on heavy lands. The heavy dense growth of vines and leaves is plowed under in the fall with disc plows. Reports received show that this treatment makes the black lands easier to work and more productive.

## Varieties of Cane.

The year 1919 was a very poor year for proving out the good qualities of improved sugar cane varieties. In a good many cases the purple, ribbon, and LaPice canes gave higher tonnages than the seedling varieties. The D 74 variety, which is the favorite cane in the alluvial sections, due to adverse weather conditions and lack of proper cultivation, did not produce its usual good yields. However, in certain favored sections, where there was less rainfall and a little more sunshine, which allowed for better cultivation, some fairly good tonnages were obtained. This clearly proves that this variety of cane must have the proper treatment in order to produce maximum returns, and, unlike the home canes, it is unable to adapt itself to adverse conditions.

The variety D 95 is being discarded by the majority of the planters. In the Parish of St. John, San Francisco plantation still plants a large acreage of this cane, and, due to its high sucrose content, it is still being retained on this plantation. Good results are also reported with D 95 in Plaquemines Parish, on Myrtle Grove plantation. Fully half of the properties are planted in this variety of cane and it is giving splendid results. The lands in this section are extremely rich and can take care of the food requirements of this variety of cane. The chief objection that planters have against D 95 is that it is too hard on the land, and the seed cane is harder to keep than the other canes.

The superiority of D 74 over home canes is still unsettled in certain localities of the State. The most successful planters of the State are planting D 74, and wherever the proper system is being used it is giving better results than the home canes. Mr. Robert, a successful planter in Iberville, claims that poor crops of D 74 stubble are the results of shallow shaving in the spring. He says, further, that if the cane is shaved deep and followed by good cultivation and fertilization

a good crop will result. In the extreme upper part of the sugar district, D 74 is giving better results than home canes when given a fair trial. On Mr. F. C. Swann's plantation, near Cheneyville, D 74 is giving more tons per acre than purple cane. Trials conducted on Inglewood plantation, near Alexandria, also proved D 74 to be superior to purple cane.

The Louisiana seedling No. 511 is still the most promising of the Louisiana seedling canes. On one plantation, Oaklawn, in St. Mary, it has been extended over an acreage of about twenty-five acres. This variety is still producing about 4 per cent more sucrose than D 74. Louisiana seedling No. 253 is the next in importance. This variety has been extended to the extent of about fifteen acres on one plantation and twenty-five acres on another. The percentage of sucrose in this cane is not very high, but on the other hand it produces a heavy tonnage.

## Sugar Cane Insects.

The moth stalk borer is still the most serious sugar cane insect pest. It is quite noticeable that in sections where fall planting is practiced on a large scale, the borers are not present in such large numbers. In sections where most of the planting is done in the spring, the borers are much more numerous and do more damage to the cane.

The non-burning of cane trash on lands that were prepared for corn was followed out by a large number of planters. On stubble cane, however, this method is considered impracticable by the majority of the planters.

Mr. E. R. Barber, of the United States Department of Agriculture, made another trip to Cuba, to continue the work of collecting cane-borer parasites. The parasites (tachinid flies) were received by Mr. T. E. Holloway at the Sugar Experiment Station and placed in cages especially prepared to receive them. Later on 180 parasites were liberated on three plantations in the State, located in the Parishes of Iberia, Iberville, and Lafourche. Mr. Holloway stated that there were not enough parasites to distribute to all of the plantations, and as there was more chance of the parasites dying out if split up in very small lots, he selected the above mentioned three central points. Investigations made several times after the pararsites were liberated showed that they were multiplying and destroying borers.

The mealy bug was found to be doing considerable damage in different sections of the cane district. This insect interferes with the proper development of the cane; decreasing the tonnage and injuring the eyes of seed cane to such an extent as to prevent proper germination. Poor stands of spring plant cane are often due to the attacks of mealy bugs. The planting of fall cane has been found preferable to spring planting in heavily infected sections. It seems that cane in the windrow provides a good place for mealy bugs to pass the winter, where they work on the cane to some extent and are in good shape for the next crop. In fall plant cane the insects are covered with soil, and as they remain in this condition, large numbers are killed out.

The Argentine ants are directly responsible for the mealy bug attacks on cane, for they foster the mealy bugs, carry them around from place to place, and help and attend them in many different ways. The ants are always found with the mealy bugs, and if the latter are plentiful it is a certain thing that there will

be hordes of ants. At the Sugar Experiment Station excellent results are obtained in controlling the mealy bugs by fighting the Argentine ants. This was accomplished by setting out cans of Government ant poison in the field. The ants were attracted by the poison and destroyed in large numbers. After a few months' time practically no ants and very few mealy bugs were found in the field, which previous to the application of the ant poison was heavily infected with both insects.

The rough-headed corn stalk beetle is another insect that occasioned some trouble in some of the Parishes, causing serious damages to stands of cane and corn. In some cases the beetles completely destroyed stands of corn and cane. The beetles feed on organic matter, and make their appearance in early spring —staying around the roots of the plants, feeding on the young, tender shoots and severing them from the mother plant. One of the most effective measures tried out was the use of nitrogenous fertilizers early in the season, which produced a quick growth and helped the plant to overcome the attacks of the beetle.

## Sugar Cane Diseases.

A complete tour of the sugar district revealed that the sugar cane root disease is quite common all over the State. The amount of injury caused by this disease depends entirely upon the cultivation and attention given to the cane. In some of the fields of stubble, where the cane was neglected, the cane had succumbed completely to the disease—producing weak, spindling stalks and a resulting low tonnage. In a good many instances the stubble was so poor that it was really unfit for the mill, and as a last resort such cane was taken for seed purposes. This is a very poor practice and expensive in the long run, for such cane is bound to be heavily infected with the disease; and as the procedure is repeated year after year the disease will become more strongly established and will actually lower the yields on the plantation.

The new sugar cane mosaic disease which was found to occur in various parts of the sugar district is causing widespread attention among the planters. A complete survey of the sugar parishes was made during the summer by a staff of Government pathologists, for determining the exact whereabouts of the new disease. A complete report of information and recommendations for the mosaic disease has been issued by the Department of Agriculture.

The mosaic disease occurred in the home canes—purple, ribbon, and LaPice, D 74, D 95, L 511, L 253, and L 231. It was found to be more generally spread in the D 74 than in the other varieties. However, the D 74 in some instances was found to be absolutely free of the disease. In the Parish of Lafayette, where only the purple cane is grown, the fields were free of mosaic disease. The same condition exists in the Parishes of Rapides and Avoyelles. In the latter two D 74 is grown to some extent and it was found to be free of the disease. The mosaic disease was found in both well ctultivated fields and in poorly cultivated fields, also in the best cane and on the best lands.

The following recommendations were advocated:

To plant healthy seed cane and discard all seed cane infected with the disease.

To plow up mosaic-infected stubble, after harvesting the cane.

To plant the more resistant varieties.

On one plantation, where 50 per cent infections were found in practically

all of the fields, special seed plots of healthy cane obtained from neighbors have been started up. The plots have been planted a good distance away from infected fields, so there will be less likelihood of the disease passing to this cane. Outside of this attempt there has been no further efforts reported where control methods are being used. The mosaic disease, while it has very probably been in Louisiana a number of years, is relatively new, and a complete study has to be made to determine the exact harm that it is doing to the cane crops of this State. In the meantime the planters should take proper precautions, learn to know the disease, and endeavor to plant healthy seed and get rid of cane infected with the disease.

## Tractors.

In spite of all of the hard and strenuous conditions of last year, the tractors made a considerable amount of progress in the sugar district. Various types of tractors were used, including two wheels, four wheels, and caterpillar tractors. In the breaking of land the four-wheel tractors were used to a greater extent than the other two types of tractors, which were used more for cultivation operations. On lands worked by the Murrell Planting Company and Cinclare all of the lands planted in fall cane were prepared with tractors. Tractors were also worked to a large extent in the Parishes of Lafourche, Terrebonne, Assumption, Ascension, Iberia, St. James, St. John, and Avoyelles.

The following is an example of some interesting tractor work on Cinclare:

Bursting out middles in corn and cane.

One tractor did the work of three four-mule teams and implements per day.

Cost of tractor work, per acre, 24c.

Cost of same work using mule teams and implements, 73c per acre. In making this calculation the time of the men and the mule feed consumed in one day was figured at 60c per head.

In the tractor cost the time of the operator and the gasoline and oil consumed during the day were taken into consideration.

In the Parish of Jefferson, Parish Agent L. W. Wilkinson reports an interesting comparison made on Willswood plantation. In destroying stubble one tractor and two men did the work of 22 mules and 10 men. The cost of tractor and implements was $1,900; of the 22 mules, $8,000.

In Lafourche Parish Mr. Roper reports that cane was cultivated and laid by with tractors. On some of the other plantations tractors were used for a few cultivations, and when the cane was too high the crop was laid by with mule teams. [J. A. V.]

# Insects Injurious to the Algaroba Feed Industry.

By John Colburn Bridwell.*

The following paper is substantially a report submitted to Mr. F. W. Macfarlane, president of the Union Feed Company of Honolulu, by which company the writer was employed from November 20, 1919, until February 1, 1920, to continue investigations of the algaroba weevils previously undertaken by him.

The work upon the algaroba weevils was then taken up by the Bureau of Entomology, with the writer in charge, and he has since been authorized to proceed to California, Arizona, New Mexico, and Texas, to study the natural enemies of these weevils there. Mr. H. F. Willard of the Bureau of Entomology is associated with him in the local end of this work.

It is appropriate now, when plans are being made to combat the weevils attacking the algaroba beans, to bring together a summary of our present knowledge of the insects involved, to indicate methods of work looking toward the prevention of future injuries, and to point out some additional lines of investigation necessary to give us the knowledge by which we may check up accurately upon the results of our remedial work.

*Insects Effecting Injuries to the Algaroba Pods.* There are four insects now effecting perceptible injury to the algaroba industry. These are three bean weevils which begin to infest the beans in the field: the Algaroba or Mesquite Weevil,[1] the Glue-bush Weevil,[2] and the Tamarind Weevil,[3] and a moth, the Indian-meal Moth,[4] which feeds in the pods during storage. The bean weevils feed principally upon the beans themselves, while the moth confines its feeding to the sugary contents of the pod outside the beans. The common bean weevil has been reported as attacking the algaroba, but this was due to an error of identification of the insect at work.

*The Algaroba Weevil.* This weevil is a native of the southwestern United States, Mexico, and, apparently, also of South America, where it attacks the seeds of the mesquites of various species and of the screw bean. It is not known to attack other host-plants there, and here it confines its attacks to the algaroba, as far as my observations have gone. While it has been reported to attack the pigeon-pea in Hawaii, I believe this record is based upon an error of observation.

This species lays its eggs singly or in small masses of from 2 to 7 or more upon the edges of the very young pods, often before they are more than an inch or two in length. When the first egg hatches from a mass, the young larva or grub begins at once to penetrate into the young pod and a copious flow of gum usually starts up from the wound made by it in feeding, and this frequently dislodges the egg-mass before others of the hatching larvae have had time to enter the pod, or it may cover the mass so as to drown them.

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*U. S. Bureau of Entomology.

[1] **Bruchus prosopis** Leconte.
[2] **Bruchus sallaei** Sharp.
[3] **Caryoborus gonagra** (Fabricius).
[4] **Plodia interpunctella** (Huebner).

The young grub entering makes an open wound in the rapidly developing pod, which, even as small as it is, permits the entrance of bacteria and molds, and the disturbance set up by them frequently causes the death of the embryo-seed opposite to it and results in the deformation of the pod at this point.

The young grub, after it has entered, feeds for some time between the two fibrous layers of the pod in the position where the sugary, pithy layer develops later. At this time this layer is extremely fluid and the grub is bathed in liquid. It makes its way about in a tiny thread-like tunnel, and when it is ready to enter the young seed has often reached a place opposite a different bean from the one near which it entered. It is not until the young beans have reached nearly full size and the seed-leaves are dark green and of a firm consistency that it enters the seed and makes its way to near the center of one of the seed-leaves and begins to feed. Upon the rich food of the seed-leaves it develops rapidly and by the time the pod has reached full length and breadth, but before it has become nearly so thick as it is when ripe, the grub reaches its full size and changes into the form of the adult weevil, or, as we say, it pupates. The pupa which is formed resembles the adult in form, but is white and very soft and delicate, and would be easily crushed if not protected by the seed and pod. It is while the weevil is in the grub stage near its full size, or in the pupa stage, that it is attacked by one class of parasites. It is encouraging to learn that the pod is then still green, it has not yet reached its full thickness, and its substance has not yet hardened so as to prevent the pararsites reaching the weevils with their stings and placing their eggs upon them.

By the time the weevils have changed from the pupa to the adult and are ready to emerge, the pods have usually reached full size and ripened and fallen to the ground, though a few of the weevils emerge just as the pods are changing color on the trees. The weevils are, then, just about to emerge from the pods when the crop is harvested and brought into storage. Certainly most of them emerge before the beans have been in storage more than a week or two. The question naturally arises: Can these emerging weevils cause an infestation of the dry pods? Here experiment in the laboratory and observation in the warehouse seem to contradict each other.

In the laboratory it is easy to secure egg-laying in the dry pods if there are openings in the pods for the insertion of the eggs, for the weevils do not seem to lay them upon the surface of the ripe pods, probably because the young grubs are unable to make their way through dry outer layers of the pod. From such dry pods adults have been bred, emerging in one case one hundred and thirty days after the eggs were laid. But in the storerooms observations made in November and December, after the beans had been in storage for more than two months, show no certain indication of reinfestation of the dry pods, and I am firmly convinced that under such conditions as these observations were made, when the weather had continued hot and dry during the period of storage, so that the pods had become very dry and hard, little or no breeding was going on. However, it is probable that considerable reinfestation of ripe beans takes place when beans are left out in the open and moistened by the rain and dew, and it is not improbable that if long-continued damp weather occurs while the beans are

in storage they may absorb enough moisture from the air to permit the weevils to breed in them even in the warehouse.

The algaroba weevil, like the other species of bean weevils, is unable to breed in the ground algaroba feed, whether pure or mixed with other feeds.

*The Glue-bush Weevil.* This weevil closely resembles the algaroba weevil, and when it attacks the algaroba seems to affect it nearly in the same way, but it also attacks the seeds of the glue-bush,[1] and, since it is known to attack other seeds in the Southwest and Mexico, where it occurs as a native, it may also be found to affect other similar seeds here. It was first found on Punchbowl in May, 1918, and was then apparently confined to that vicinity, but since that time it has extended its range from Koko Head to Kaena Point. It was first found here attacking the seeds of the glue-bush, which seem to form its principal food in its native home, but was soon bred experimentally from dry algaroba pods, and it was recently found to constitute 27% of a small lot of weevils bred from algaroba pods at Waikiki by Mr. C. E. Pemberton. Out of about 3,000 weevils picked up dead in the Union Feed Company's warehouse, about 1% were of this species. We can only conjecture whether it will become a pest of first importance in the algaroba beans or if it may not after a time confine itself more closely to the glue-bush.[2]

*The Tamarind Weevil.* This weevil is usually much larger than the other two. Its eggs are considerably larger and are laid scattered singly over the pods of the plants which it infests. It also attacks the seeds of the tamarind, as its name suggests, and it may have been brought in these seeds from India, which is its native home. It also breeds in the seeds of the golden shower, pink shower, pink-and-white shower, two species of *Bauhinia,* the glue-bush, and other leguminous shrubs and trees.

Its attacks upon the algaroba differ from the other two bean weevils in two important ways. First, a single grub rarely finds enough food in a single bean, but devours two or three before it reaches full growth, and, second, the eggs are usually laid after the pods are ripe, so that the eggs are just hatched or hatching when the beans are brought into storage, and consequently practically all the damage done by it occurs after the beans are in the warehouse.

*The Damage Done by the Various Weevils.* We have no data sufficient to enable us to estimate the amount of damage done by the weevils, but observation makes it apparent that the losses are very serious. In one small lot examined, which was obviously much less infested than many of the beans brought in during the present season, 25% of the beans were eaten or missing, and in my judgment practically all this loss was due to the weevils. It will require considerable further work to secure data upon which to base any accurate estimate of the losses and to divide it between the two weevils whose work is done at the beginning of storage and the one doing its work in storage, but as a rough guess I should say that perhaps two or even three times as much damage is done before as after storage. It is important that such data should be collected, so that we can check up on the results of any work undertaken.

*Parasites of the Bean Weevils in Hawaii.* Two species of parasites are

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[1] Acacia (Vachelia) farnesiana.

[2] More recent observations seem to indicate that this species will prove to be even a worse enemy than the algaroba weevil.

doing considerable beneficial work in checking the multiplication of the Algaroba weevil and the Glue-bush weevil in Hawaii, and one of them is doing even better work against the Tamarind weevil. The first of these is an egg parasite, *Uscana semifumipennis* Girault, attacking all the species, and a larval parasite, *Heterospilus prosopidis* Viereck, which is not yet known to attack the Tamarind weevil.

*The Egg-Parasite, Uscana.* This is an exceedingly small, four-winged fly, barely visible to the naked eye, which by means of its sting or ovipositor bores a minute hole into the egg of a bean weevil and inserts its own egg within. From this a minute grub emerges and feeds upon the contents of the weevil egg and in due time produces a fly like its parent, so that the weevil egg, instead of producing a grub to feed in the seed, gives forth a fly to attack other eggs.

The algaroba weevil and the glue-bush weevil, as has been said before, lay their eggs usually in masses of from two to seven or more. In the masses where more than two eggs are present one or more eggs are so overlaid by the others that the parasite is not able to reach it, and thus, even if part of the eggs are parasitized, one is likely to escape and produce a grub. For this reason the tamarind weevil, which lays its eggs scattered, is more heavily parasitized than the others, and all the lots of eggs examined recently show that from 70–90% of the eggs are destroyed, but even in the case of the others it is probable that from 60-70% are usually attacked.

This parasite has been known for about ten years in the Islands, and it is probable that we are deriving all the benefits from it which it is capable of affording

*The Larval Parasite, Heterospilus.* This is a reddish, four-winged fly, considerably smaller than a housefly, which has the power of finding the grubs of the weevils in the pods or seeds and boring with its ovipositor down through the pod, stinging and placing its egg upon the body of the grub. From this egg the grub of the pararsite develops and feeds upon the weevil grub, which has been paralyzed by the sting. In due time the adult parasite emerges from the pod through a hole much like that made by the weevil in emerging. The parasite seems to be very irregular in the extent to which it attacks the weevil grubs, but in some cases it appears to do considerable good. This pararsite was introduced about ten years ago by the Federal Experiment Station, and it is probable that it is by this time doing as effective work as it will ever do.

*The Attacks of the Indian-meal Moth.* This is a small moth which, as its name implies, commonly attacks corn meal, though it is not the most common moth doing such damage in the Islands. It is known to attack many kinds of stored foods and feeds. It is at present breeding in considerable numbers in the algaroba warehouse.

The eggs are laid by the moths on the bags in which the beans are stored, and the young caterpillars hatching from them find their way into the bag and enter preferably broken pods, where they feed upon the sugary pith. After reaching full growth the caterpillars leave the pods and crawl about in search for a place to change into the adult moth. This they usually find on the surface of the bag where it touches another bag or in other crevices about the warehouse. Here the caterpillar spins a loose silken cocoon and shortens up, becomes inactive and sheds its skin to disclose the brown pupa. While the caterpillars are

crawling about in search of hiding places for the cocoons they are subject to the attacks of their enemies, of which three have been observed at work in the warehouse. These are the red fire ants, which devour them bodily; a small bug, which pierces the skin and sucks out the juices from their bodies; and a common parasite of moths in stored food products, which first stings the caterpillar and then deposits its own eggs upon it, and the grubs hatching from these eggs devour the caterpillar and develop into the parent form, several grubs feeding on a caterpillar.

It is not easy to estimate the amount of damage done by this moth, and the only remedial measure I should at present suggest is to subject the bags in which the beans have been stored to some sterilizing process, either heating them in the drier or fumigating them. This is suggested because the caterpillars or pupae are frequently sent out with the bags and are often not destroyed in handling, and thus serve to infest the new beans, probably sooner than they would be otherwise. Indeed, this would be advisable as a general practice with all bags as they are emptied, so as to destroy any vermin they may contain.

*Remedial Measures Against the Weevils.* The remedial measures which seem advisable may be considered under two heads, according to their being directed against the weevils in the warehouse or in the field. Work in both lines seems called for, since the bulk of the injury done by the tamarind weevil and the meal moth is done after the beans are in storage, and many of the other weevils which are in the pods at the beginning of storage now escape which might be killed then and retained to contribute to the nitrogen contents of the feed. Such measures would also tend to insure the beans against any reinfestation which may take place under special conditions. It must not be considered, however, that this treatment will in any way change the beans so that reinfestation cannot take place from outside. It is only that all the weevils in the bags should be killed at the time the beans enter storage. On the other hand, the bulk of the damage done to the beans by the algaroba weevil and the glue-bush weevil is done before the beans are brought into the warehouse.

*Remedial Measures in the Warehouse.* Two methods of killing the weevils in the pods naturally suggest themselves. If it were possible to subject the beans at once to the regular process of drying, so that they were at once heated through to a temperature of from 120° to 140° F., the weevils would be killed by the treatment. But since, as I have been informed, the natural drying of the beans for three months or more in the warehouse effects so great an economy of fuel as to make this storage a practical necessity, particularly as other conditions of the harvest and the plant also forbid the employment of this procedure except under special conditions, we need not consider this idea further.

There remains, then, fumigation of the beans as they enter the warehouse. It might seem that this could be done in the warehouse itself, but all recent investigations of fumigation show that the adaptation of such buildings to fumigation is not practical, since it is not possible to make such a building tight enough to insure success in the operation. With this in view, it is probably best to consider only fumigation in a plant specially constructed for the purpose. There is a set of fumigating rooms maintained in Honolulu for public use by the Territorial Board of Agriculture and Forestry, under the direction of Mr. E. M.

Ehrhorn, which is available for anyone to use if he supplies the chemicals and labor necessary, but it would not seem to be practical for any company handling large quantities of beans. Such firms would need to have their own fumigating rooms. This plant, I am informed, cost about $2,700, and, allowing for construction on a somewhat modified plan, a plant adequate for handling up to 500 bags a day might have been constructed for about the same amount of money at the time when this was built, but at present I believe the cost of construction would be considerably higher. So far as I understand the conditions of the incoming crop of beans, as handled by any firm at present, it would seem that two rooms, each with a capacity of a thousand bags, should handle them as they come in. One side could be filled and fumigated and the other used to receive the incoming beans while the charge in the first operates. Ordinarily 48 hours is considered desirable, though experience may show that less time will serve in a tight cement building. Such a plant would also handle other fumigation required in other lines of business as well.

*Measures Against the Weevils in the Fields.* Whatever good results are secured by the fumigation of the beans at the time of bringing them into storage, the larger amount of damage done by the algaroba weevil and the glue-bush weevil will remain. There seems to be no other means of reaching this injury besides the importation of the natural enemies of these insects.

Both the weevils in question are natives of the southwestern United States and adjoining Mexico, and it is natural that we should first look to these regions for such enemies. There are several such already known from there attacking both species of weevils. These were made known as the result of some work by the Federal Bureau of Entomology upon the parasites of the cotton boll weevil about twelve years ago, and the bean weevils were investigated only incidentally and principally in the cotton belt of Texas, and it is probable that an investigation of the parasites of the algaroba and glue-bush weevils over the wider extent of the range of the screw-bean and mesquite would result in the discovery of many other important enemies there.

While it is impossible to forecast the results of such work or to plan it very definitely in advance, it may be desirable to discuss the general ideas in mind regarding such work.

The enemies under consideration fall into three classes: egg-parasites, larval and pupal parasites, and enemies of the adults.

*Egg-Parasites.* The egg-parasite at present found in the Islands is doing such good work that we can hardly expect any improvement from any insect working in the same way. However, in the case of some other insects which lay their eggs in masses as these weevils do, there are parasites which have grubs which, instead of confining their feeding to a single egg, as this one does, pass from one egg to another. If such a parasite could be found for the weevils this would of course be very desirable, but since our parasite seems to be the only egg-parasite of such weevils at present known, we can only hope to find a better.

*Larval and Pupal Parasites.* Of the larval parasites several are known which attack the grubs and pupae in the pods, and it is quite possible that some of these may be much more effective than the one now present in the Islands. As it is, but very little is known about their manner of life, and it seems of ut-

most importance to secure as many different ones of these as possible and study their habits. There is every probability that the greater number of species of these which are present, the greater the actual number of weevils destroyed will be, since each species is likely to have some little peculiarity of habit which will enable it to attack some individuals which have escaped the others.

*Enemies of Adult Weevils.* Regarding enemies of the adults, there is but one group which seems to me likely to give useful results. This is a group of digging wasps of the genus *Cerceris.* To avoid any misunderstanding, I may say to begin with that, as the entomologist uses the term wasp, he includes many insects very much unlike the stinging social wasps ordinarily thought of when the term is used. These wasps do not sting and can be handled with impunity. The wasps referred to belong in a general way to the same group as the *Scolia,* which has done so good work against the *Anomala* and the Japanese beetle, and the less well known *Dolichurus,* which has been introduced from the Philippines and has greatly reduced the numbers of a small cockroach found in the mountains here. The wasps of the genus *Cerceris,* many of them, capture adult beetles and bury them in the ground or place them in cells in hollow twigs, and thus provide them for food for their grubs. Each species usually selects beetles of a particular group for its prey and largely confines itself to that group. While no American species is known to attack the group of weevils to which the pests we have under consideration belong, at least three European species do so, and it is quite likely that when the species from the regions where our pests are native are studied some of them will be found capable of using them and can be successfully introduced into the Islands. If such should prove to be the case, we have every reason to hope from the experience we have had with the *Scolia* and the *Dolichurus* that they will prove effective in the control of the weevils.

## The Relative Availability of Nitrate Nitrogen and Commercial Organic Nitrogen.*

By A. W. Blair.

The question of the availability of nitrogenous fertilizers is one of great importance to the farmer. He desires a material that will be sufficiently available to benefit the immediate crop and at the same time he wishes to guard against undue loss of plant food through leaching.

It is a matter of perhaps equal importance to the fertilizer manufacturer, since he wishes to sell the farmer a fertilizer that will give results, and also to use all the available by-products that may be worked into fertilizers.

Since nitrates are readily soluble in water and are assimilated directly by plants, they are considered readily or immediately available materials. Organic

*The American Fertilizer, Vol. 52, March 13, 1920. Reprinted from the Journal of Industrial and Engineering Chemistry.

nitrogenous materials must undergo decomposition in order that the nitrogen may be converted into ammonia and nitrates, and are therefore considered less readily available than nitrates. If, however, we allow sufficient time for their decomposition, will they not give as good results as the nitrates; that is, does the greater residual effect of the organic matter balance the ready availability of the nitrates? In other words, taking results covering a period of years, is a pound of nitrogen in the form of organic matter as effective as a pound of nitrate nitrogen?

For more than twenty years the New Jersey Experiment Station has been making a study of the availability of different nitrogenous materials and the results of much of this work have been published. It seems worth while, at this time, however, to summarize briefly certain phases of this work, and to include new material which has not yet been published. In much of this work the comparison was confined to a nitrate and an organic compound, and on this account this discussion will be confined to results obtained with nitrates and organic materials. The work has been carried on by means of field, cylinder, and pot experiments. The pot experiments constitute a minor part and need not be reported here.

## Cylinder Experiments—Series A

The work that has been carried on in these cylinders was originally outlined under the rather broad heading "Investigations Relative to the Use of Nitrogenous Fertilizers," and includes other phases of the nitrogen question than the one immediately under discussion. The soil is a loam (Penn Loam) and has a depth in the cylinder of about 8 inches. This top soil rests on a sub-soil, the whole having a depth of about 45 inches. Lime and mineral fertilizers (acid phosphate and muriate of potash) have been applied regularly, and thus, as far as possible, nitrogen is made the limiting factor.

One cylinder receives no nitrogen and thus becomes the check; one receives nitrate of soda at the rate of 320 pounds per acre, and one receives dried blood equivalent to the nitrate.

A five-year rotation is practiced on these cylinders, and the results are now available from four such rotations, giving a continuous 20-year record. The rotation consists of a year of corn, two years of oats, one year of wheat, and one of timothy. Fertilizers are applied for each of these main crops. A residual crop of corn follows each oat crop, but no additional fertilizer is applied for the corn.

A careful record is kept of the amount of nitrogen applied to each cylinder and also of the amount of dry matter harvested and the nitrogen removed by the crops. Wheat is harvested at maturity and saved as grain and straw. All other crops are harvested as hay or forage and reported as dry matter. In the accompanying table, grain is included in total dry matter.

The average yield of dry matter and the percentage of nitrogen recovered for the twenty years are summarized by ten-year periods in Table I.

TABLE I

| Treatment | Grams Dry Matter per Cylinder | | Per Cent Nitrogen Recovered | |
|---|---|---|---|---|
| | 1st 10 Yrs. | 2d 10 Yrs. | 1st 10 Yrs. | 2d 10 Yrs. |
| Nitrate of soda ....... | 237 | 243 | 60.48 | 64.35 |
| Dried blood ........... | 207 | 185 | 39.90 | 37.48 |

From these figures it will be observed that the nitrate has given larger yields and a higher nitrogen recovery than the blood. The nitrate shows an average nitrogen recovery of 62.4 per cent, while the dried blood shows a recovery of 38.7 per cent. Furthermore, the yield with nitrate is slightly higher for the second 10-year period than for the first, while the reverse is true for the dried blood.

Taking the 20-year average, the dried blood shows an availability of 62 on a basis of 100 for nitrate. From the standpoint of the yield of dry matter, however, dried blood shows a yield of 81 on a basis of 100 for nitrate.

## Cylinder Experiments—Series B

It is generally understood that nitrogenous fertilizers may have different effects in different soils. For example, in a heavy clay soil organic materials would decay more slowly than in a light sandy soil, and there is a possibility that in the light soil the loss of nitrate nitrogen through leaching might be greater than the loss of organic nitrogen, even when used in equivalent amounts.

In order that a study might be made of the relative availability of nitrogen in the form of nitrate of soda and dried blood in soils varying in mechanical composition, 60 cylinders were arranged in ten series of six cylinders each and prepared for the growing of crops. All cylinders were filled with a uniform subsoil to within about ten inches of the top, and the soils to be studied were laid on these to a depth of about eight inches. The first six cylinders (Series A) were filled with a loam soil, the second six (Series B) were filled with the same soil containing 10 per cent of coarse white sand; the third six (Series C) were filled with a loam soil containing 20 per cent of the sand, and so on to the tenth series (Series J), which were filled with pure sand (a 60 per cent sand series was not included).

All cylinders receive each year a liberal application of carbonate of lime, acid phosphate, and muriate of potash. Two in each series receive no nitrogen (that is, they are the check cylinders); two receive 10 g. of nitrate of soda, and two receive dried blood equivalent to the 10 g. of nitrate.

A crop of barley and a residual crop of buckwheat are grown each year, all the fertilizers, however, being applied to the first crop. The two crops are harvested and samples analyzed for nitrogen without separating grain and straw. Yields are reported as total dry matter. The results of seven years (1912 to 1918, inclusive) are now available and summarized by averages in Table II. From this summary it will be noted that the yields from the nitrate cylinders are greater than those from the blood cylinders throughout the series until the 100 per cent sand series is reached. Here the lasting qualities of the blood are

shown by a yield of 70.2 g. of dry matter as against 56.7 g. for the nitrate. It is of interest to note that the yields with both materials are well maintained up to and including 50 per cent of sand. Especially is this true of the nitrate as shown by the seven-year average of 155 g. for cylinder F—50 per cent sand—as against an average of 151 g., for the same period, for the four series having 10, 20, 30 and 40 per cent of sand, respectively. The corresponding figures for the blood are 123.2 g. as the seven-year average for the series having 50 per cent sand, and 134.5 g. as an average for the four series having 10, 20, 30 and 40 per cent sand, respectively.

TABLE II

AVERAGE YIELD OF DRY MATTER AND PER CENT NITROGEN RECOVERED ON SOILS VARYING IN MECHANICAL COMPOSITION — 1912–1918. CROPS: BARLEY AND BUCKWHEAT

(1) Yield of Dry Matter—Grams per Cylinder

| | Loam | Per Cent Sand | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Soil | 10 | 20 | 30 | 40 | 50 | 70 | 80 | 90 | 100 |
| Nitrate of soda | 149 | 159 | 146 | 152 | 149 | 155 | 137 | 113 | 104 | 57 |
| Dried blood | 142 | 148 | 131 | 132 | 127 | 123 | 112 | 110 | 92 | 70 |
| Check | 80 | 89 | 68 | 67 | 65 | 67 | 47 | 43 | 29 | 18 |

(2) Average per Cent Nitrogen Recovered

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrate of soda | 54.8 | 51.8 | 57.6 | 61.2 | 60.2 | 61.3 | 60.4 | 46.8 | 50.9 | 31.8 |
| Dried blood | 43.8 | 45.2 | 46.0 | 48.2 | 45.5 | 41.2 | 46.6 | 48.8 | 45.1 | 39.1 |

Since the yields were greater with nitrate than with dried blood, even where the soil was 50 per cent coarse sand, it seems evident that the loss of nitrate nitrogen must have been less than the loss of organic nitrogen, though we have been accustomed to think that the reverse is true in soils containing considerable sand.

The percentage of nitrogen recovery is well maintained for both nitrate and blood in soil mixtures containing as high as 70 per cent sand. Indeed, where the nitrate was used, the recoveries are higher with 30, 40, 50 and 70 per cent sand than with 10 and 20 per cent sand. Where blood was used, the highest average recovery was with 80 per cent sand and the next highest with 30 per cent sand.

## Field Experiment.

In a study of so important a problem, it did not seem wise to rely entirely on cylinder experiments for data, and therefore, in 1908, 40 one-twentieth acre field plots were laid out for use in a detailed study of the relative availability of a number of nitrogenous materials. Since calcium nitrate was claiming attention as a fertilizer at this time, it was included among other materials. The figures reported herewith in Table III are the averages of ten years' results from the sodium and calcium nitrate plots on the one hand, and the dried blood, fish, and tankage (organic nitrogen) plots on the other.

TABLE III

AVERAGE YIELD OF DRY MATTER AND PER CENT NITROGEN RECOVERED —FIELD EXPERIMENTS, 1908–1917

| Treatment | Average Pounds Dry Matter per Acre | | Per Cent Nitrogen Recovered | |
|---|---|---|---|---|
| | First 5 Years | Second 5 Years | First 5 Years | Second 5 Years |
| Nitrate nitrogen, no lime | 4191 | 3432 | 38.2 | 31.8 |
| Nitrate nitrogen, with lime | 4467 | 3462 | 51.0 | 28.8 |
| Organic nitrogen, no lime | 3821 | 2856 | 27.3 | 25.4 |
| Organic nitrogen, with lime | 3734 | 3063 | 28.5 | 24.9 |

A 5-year rotation has been followed, the crops being for the first 5-year period, one year of corn, two years of oats, one year of wheat and one year of timothy. For the second 5-year period the rotation was slightly changed, so that there was only one year of oats and two years of timothy. A careful record has been kept of the total dry matter produced and of the amount of nitrogen applied as fertilizers, and of the amount removed by the crops.

It will be noted that the nitrate plots gave the largest yield of dry matter and the highest recovery in both periods.

If an average is taken of the yields of dry matter from the limed and unlimed nitrate plots and the limed and unlimed organic fertilizer plots, it is found that the difference is close to 500 pounds annually in favor of the nitrate plots for each of the two 5-year periods. The average nitrogen recovery of all the nitrate plots for the ten years is 37.4 per cent, as compared with 26.5 per cent for the organic fertilizer plots.

The reason for the greater effectiveness of nitrate nitrogen than organic nitrogen is not entirely clear, but the residual crop which is grown every year in cylinder experiments (Series B) seems to throw some light on this question. This crop gets practically no benefit from the nitrate—the first crop having utilized practicaclly all that was not lost in some way—whereas it is benefited slightly by the dried blood. In other words, the organic nitrogen does have a slight residual effect, whereas the nitrate has practically no residual effect. However, the initial effect of the nitrate so much exceeds the initial effect of the organic nitrogen that the total recovery is distinctly in favor of the nitrate. It would appear, therefore, that the nitrate is especially beneficial to the plant in the early stages of its growth at a time when the organic material has not yet become fully effective, and having thus obtained a good start, the plant grows rapidly and utilizes the nitrogen to such good advantage that the loss is really less than from a material that is not so readily soluble. Furthermore, the good start which the nitrate gives the plant enables it to utilize the soil moisture and mineral plant food to better advantage than the plant that starts slower. [W. P. A.]


Plate I. Lahaina root response to chemical treatment. Figs. 1 and 6, inoculated with **Pythium**, Fig. 1 chemically treated; Fig. 11, uninoculated control 1, untreated.


Plate II. Lahaina root response to chemical treatment. (Duplicate series.) Figs. 7 and 8, inoculated with **Pythium**, Fig. 7 chemically treated. Fig. 12, uninoculated control, untreated.

# Lahaina Disease Responds to Chemical Treatment.

By C. W. Carpenter.

In a pot experiment with Lahaina cane recently concluded, evidence was secured which clearly indicates the possibility of controlling the Lahaina disease by chemical treatment. The effect of the treatment on root development was very striking, and while the experiment does not necessarily indicate that the treatment applied is the most practicable one, it does show that chemical treatment has great possibilities. The experiment furnishes a basis for further work, and lends encouragement to the belief in our ultimate success in controlling the disease. In this note the facts of the experiment are put on record for what they may be worth, field experiments by the writer not yet being started.

A series of twelve Lahaina cane plants were started in steam sterilized soil early in December, 1919. On December 20th six of the plants were inoculated by placing some of the *Pythium* type fungus in the soil. On January 28th three more plants were similarly inoculated. On April 10th, when the disease was well in evidence, 50 cc. of a one per cent. solution of "Qua-Sul"[1] was applied to one pot (9 in. in diameter) of each series of inoculations. The controls, treated and untreated inoculated plants, were watered the same, and otherwise given identical conditions.

The roots of the plants were washed out on May 28th, 1920, with the striking differences in the root systems shown in the plates. This was 48 days after treatment of the two pots when the plants had ceased to develop in the limited soil.

In contrast to the untreated sick plants (Pl. I Fig. 6, Pl. II Fig. 8), whose root systems were limited to a few rotted primary roots, and practically no secondary feeding roots, the plants in the chemically treated soils (Pl. I Fig. 1, Pl. II Fig. 7) showed a remarkable new root system with a considerable quantity of secondary feeding roots. In fact, at the time washed out, these treated plants had a more extensive root system than the control plants in uninoculated soils, which, however, is susceptible of explanation. The uninoculated controls grew normally and exhausted the limited soil available at a relatively early period, after which time the roots gradually crowded each other out and died of impoverishment. The inoculated plants, on the other hand, lost their feeding roots as fast as formed until the chemical treatment was applied. In these pots there was still plenty of room for the development of a good root system as soon as the root parasite was checked by the chemical. In those inoculated pots not chemically treated the root system remained in a crippled condition.

Judging by the meager data thus far obtained, field control and prevention might be possible by applying the "Qua-Sul" to the soil in advance of laying the seed, and to growing cane in advance of irrigation, or applying the material at greater dilution in the irrigation water. The water then could carry the material into the foraging ground of the secondary feeding roots, where it must be to

[1] "Qua-Sul" is a soluble sulphur-carbon compound, manufactured by the A. R. Gregory Company of San Francisco.

check the fungus. Field experiments along the lines indicated have been projected for some time, and their inauguration only awaits the preparation of the soil.

In a similar way the writer demonstrated that repeated irrigation of pots of artificially induced Lahaina disease with 1–50,000 copper sulphate solution checked the disease of the roots, the plants putting out new roots in a normal manner, and the above ground portion of the plant showing improvement. Pot experiments allow only a limited range of observations, and are suitable chiefly as indicators for field experimentation. Such factors as time and periods of application, amounts to apply, as well as the ultimate cumulative effect on future crops, will all have to be taken into careful consideration before such potent chemicals are extensively used.

From our observations on the occurrence of Lahaina disease, and the pineapple "wilt," the most likely time to apply chemical treatments would be in the fall and winter months, when the plants are at the lowest ebb of vegetative vigor, at which times the fungus appears to do the most of its damage. Then treatment, if applied opportunely, would be more preventive than remedial in nature.

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